

**Integrative Risk Management:
Advanced Disaster Recovery**
Risk Dialogue Series

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Contents

Preface	4
Raj Singh – Swiss Re	

Introduction	7
Stephan Schreckenberg, Annabelle Hett – Swiss Re Centre for Global Dialogue	

Chapter 1:	
System level risk	11
Understanding and coping with the increasing risk of system-level accidents	13
Herman B. “Dutch” Leonard, Arnold M. Howitt – Kennedy School of Government, Harvard University	
International Risk Governance Council’s risk governance framework: Appropriate governance for ignored and emerging global risks	27
M. Granger Morgan, Christopher Bunting, Marie Valentine Florin – International Risk Governance Council	
Broad horizons: The Global Risk Report and a holistic risk assessment	35
Sheana Tambourgi – World Economic Forum	

Chapter 2:	
Preemptive risk management strategies	43
Advance recovery and the development of resilient organisations and societies	45
Herman B. “Dutch” Leonard, Arnold M. Howitt – Kennedy School of Government, Harvard University	
Country risk management: Managing interrelated risks at country level	59
Jack Radish – Organisation for Economic Cooperation and Development	
Catastrophe financing in middle- and low-income countries: Framework and operations of the World Bank Group	67
Olivier Mahul – World Bank	
Integrative risk management for the public sector: The role of (re)insurance in providing innovative risk transfer solutions	83
Raj Singh, Reto Schnarwiler, David Bresch – Swiss Re	

Chapter 3:	
Lessons learnt from climate risk	97
Managing Africa’s natural disaster risk	99
Joanna Syroka, Richard Wilcox – United Nations World Food Programme	
Addressing the challenges of climate change	109
Thomas Stocker, interview by David Bresch – Intergovernmental Panel on Climate Change	

Preface

It is not easy to statistically validate the statement “we live in a more complex and interconnected world”. The scope of the statement is vast. It encompasses global trade and investment flows. It includes just-in-time production methods and multiple payment possibilities. It highlights the impact of changing technologies and increasing technological dependence. It captures growing levels of urbanisation and substantial migration patterns. It registers the rise of the virtual economy and the explosion in web-based social interaction. It notes widespread suffering of economic externalities and the common challenges we face in utilising sustainable resources.

The message for those managing risk is that no measure of exposure can be taken in isolation. Understanding the risk associated with a particular person, event or object has to be weighed together with the multiple contingencies and dependencies surrounding the particular risk. It is in this spirit of a holistic understanding of risk that integrative risk management is being developed. Looked at over a twenty-year period, risk management has evolved into an independent discipline driven by a combination of external events, advances in modelling and an increasing awareness of large-scale and interconnected risks. The latter theme is increasingly being endorsed not only within the financial industry, but also by other sectors, policy makers and international institutions..

Swiss Re has been at the forefront of promoting integrative risk management approaches. We have twin motivations for increasing the understanding of integrative risk management.

Firstly, modern risk management - both in the public and private sector - relies on integrated risk assessments. As such it must take a portfolio approach to all risk categories and their interdependencies. This requires strong collaboration across various disciplines. This includes prevention, mitigation, and recovery efforts, including developing new risk transfer solutions. Encouraging stakeholders to jointly develop the tools and the culture to effectively deal with inherent risk and exogenous shock will foster greater resilience among individuals, companies and countries. This, in turn, will contribute to improved long term economic growth, and the ability of society to take on new entrepreneurial risks.

Secondly, the techniques of this emerging discipline help insurers better manage their own risk exposure. Few businesses can match the breadth and diversity of business that the insurance industry carries on its portfolio. These risks, together with their interdependencies, have to be rigorously appraised, understood and balanced within our overall business model. In doing so, we can seek to offer solutions that lie within the company's exposure limits to the interconnectivities of one particular event or trend; while being able to price selected business at a risk adjusted level that brings suitable returns for our shareholders.

The following thought provoking articles on integrative risk management have been written by some of the foremost experts in their field, representing leading global academic organisations, think tanks, international financial institutions and governmental bodies involved in increasing and in utilising the understanding gained.

We hope this collection provides impetus to this emerging discipline, and stimulates further debate in search for appropriate solutions as we navigate our increasingly complex risk landscape.

Raj Singh, Chief Risk Officer, Member of Executive Committee, Swiss Re



In an increasingly integrated and interdependent world, any economic activity can be affected by major events elsewhere.



Introduction

The growing complexity of our everyday existences provides the backdrop to the growing complexity of the risk that societies face. The attack of 11 September 2001 cannot be understood in a satisfactory way by merely describing it as a hijacked aircraft flying into a building; years of seething political discontent and inadequate airline security came together in an area of massively concentrated economic significance. Hurricane Katrina was a devastating storm; but the influence of the storm itself was considerably increased by a number of factors, from insufficient flood protection to ill-prepared post-storm relief measures. The global economic crisis of 2008 brought together the risks of a highly indebted shadow banking system leveraged on a relatively narrow base of housing assets, exacerbated by the prevailing regulatory and accounting system

These examples demonstrate the growing importance of the economic, technical, social and political context in determining whether a particular occurrence has sufficient momentum to transform an event into a catastrophe. This context stems in large part from decisions made in private and public spheres; there is, therefore, the potential to influence the type and severity of the consequences flowing from the risks to which society is exposed.

Integrative risk management seeks to advance our understanding beyond immediate cause and effect relationships of a catastrophe. While one usually tries to define the scope of investigation, or system boundary, as narrowly as possible in order to keep descriptions of the system lean, feasible and comprehensible, catastrophic events often impact across an unexpected breadth of issues and subject matter.

By embedding those events into the chains and systems that bind economies and societies, integrative risk management studies the interconnections and consequences of trends or events. At the same time it seeks to shed more light on the circumstances that cause a trend to emerge or an event to take place. The insights gained from this approach facilitate the development of means for the public and private sector to better address those challenges.

This approach to risk is increasingly being integrated into policy processes and risk management planning at company as well as at institutional level; in particular regulators have begun to advocate a more holistic view of risk.

The public sector is also showing increasing appreciation of this approach. Here the focus lies on risk identification and adoption of subsequent mitigation and adaptation measures. A number of governments are establishing offices to coordinate risk responsiveness between ministries. There is also increasing attention being paid to post-event recovery, and how it should best be administered and fostered. In developing and emerging economies, with less financial resources to draw on in a time of peril, work is being undertaken to allow funds to be quickly provided post-event.

For this publication we have identified a number of leading analysts and practitioners working within and around the field of integrative risk management. They represent leading global international institutions, from academic experts through to practitioners. In doing so we hope to construct a firm bridge between theory and practice from which new ideas might develop.

The primary focus of the authors of this particular publication is advanced disaster recovery. This encompasses both an ability to better identify and pre-empt potential disaster as well as the most effective means of managing post-disaster recovery.

The first part of the publication discusses the analysis of system-level risks: understanding what can lead to system breakdown; pinpointing where risk governance deficits exist; and identifying the developing trends on the global risk landscape. Herman B. “Dutch” Leonard and Arnold M. Howitt of the Harvard Kennedy School of Government introduce the concept of designed and self-generating systems. These systems function within boundaries; however, these boundaries become stretched as systems become increasingly interconnected and interdependent. This leads to a greater vulnerability in systems, which can ultimately result in system level accidents. M. Granger Morgan, Christopher Bunting and Marie Valentine Florin of the International Risk Governance Council (IRGC) demonstrate a systematic approach to both identifying potential risk governance deficits and establishing how to subsequently manage those potential deficits. Their examples demonstrate the applicability of the advocated approach for a variety of risks. Sheana Tambourgi, from the World Economic Forum, describes how the Global Risk Report attempts to take a top-down approach at understanding the global risk landscape and the interconnections between various categories of risk.

The second section of the publication focuses on ways in which an ex ante strategy in managing risks can alleviate the consequences of major risk events. In their second article, Herman B. “Dutch” Leonard and Arnold M. Howitt analyse how responses to a risk event can have a significant effect on societal resilience and subsequent economic recovery, with a particular focus on post-Katrina New Orleans. Their analysis leads them to the conclusion that a main emphasis of disaster risk management should be on a proper ex ante preparation of potential response or mitigation strategies, including potential financing needs. The article by Jack Radisch, of the Organisation for Economic Cooperation and Development, summarises the various approaches taken by governments in managing an increasingly complex risk portfolio at a state level. Olivier Mahul, of the World Bank, notes how the World Bank has developed a platform that facilitates the origination of ex ante funding structures to allow countries – particularly those with little depth in their financial markets – to easily access post-event liquidity and funds, most notably in the form of catastrophe bonds. Swiss Re’s Raj Singh, David Bresch and Reto Schnarwiler demonstrate how the insurance industry is well positioned to provide business solutions that contribute in such circumstances to mitigating risk and promoting growth and development. They illustrate business cases for structuring products such as catastrophe bonds that are issued on the global capital markets

The final section of the publication focuses on two major and highly interconnected risks that relate to climate developments. One of these is the ability to provide sustenance to a growing global population. Joanna Syroka and Richard Wilcox of the United Nations World Food Programme (WFP) highlight the role of risk assessment and risk management tools in seeking to preempt and manage food shortages. They describe how the WFP has developed advanced mapping software, including a number of spatial data sets, which can provide a much better overview of potential famines and the best measures that can be taken against them.

Last but not least Thomas Stocker, co-chair of Working Group 1 of the Intergovernmental Panel on Climate Change (IPCC) – the IPCC Working Group which assesses the physical scientific aspects of the climate system and climate change – shares in an interview some of the experiences and lessons learnt from tackling climate change globally. The IPCC is one of the few organisations in which science specifically supports policy-making and decision-taking in the face of high uncertainty.

We hope that the articles in this edition of the RDS lead to a stimulating debate that will ultimately further the development of adaptation and mitigation measures through which societies can become stronger and more resilient.

Stephan Schreckenberg, Head Risk Research Relations, Swiss Re Centre for Global Dialogue
Annabelle Hett, Head Swiss Re Centre for Global Dialogue

Chapter 1: System level risk



The world's urban population now exceeds the world's rural population. The growth of towns and cities concentrates risk and the interdependencies of risk.



Understanding and coping with the increasing risk of system-level accidents

Herman B. “Dutch” Leonard, Arnold M. Howitt¹ – The world has seen a number of recent events in which major systems came to a standstill, not from one cause alone but from the interaction of a combination of causes. System-level accidents occur when anomalies or errors in different parts of an interconnected system negatively reinforce one another, spiraling up out of control until they eventually drive the system outside of its sustainable boundaries, resulting in system “collapse”. Systems with multiple components that are tightly linked to one another are prone to such events. Increasingly, our industrial, commercial and social systems are coming to have the characteristics that predict system-level accidents – in some cases, driven by consistent economic forces that cause tighter interconnections to form within existing systems – and there seems to be a rising frequency of such events. Since we inhabit an increasingly tightly interconnected global collection of such systems, finding ways to reduce and to manage systemic risk is an important priority.

A particularly heavy snow storm in South China in 2008...

For nearly a month in January/February of 2008, an unusual weather pattern in South China produced a series of snow and ice-storms that were distinctly out of the ordinary. The snow, combined with icing of power lines (and associated power outages), snarled traffic from railroads to highways and disrupted factories, schools, government services and households. To be sure, the weather was significantly worse than normal. Normally, if snow falls at all in this region, its appearance is brief and its effects transitory. This time, the snow came and stayed and came again.

...coinciding with a national celebration led to multiple system failures.

Even allowing for the fact that the snow was worse than is normally encountered in this region – this event was widely described as the worst series of snow and ice events of the last 50 years – the impacts of this event seemed out of proportion to the event itself. Everything seemed to go wrong at the same time. The snow arrived on the eve of the spring festival, when millions of Chinese citizens, who have gone to work some distance from their homes, seek to return to their places of origin to celebrate the new year. Half a million people wound up crowded into the Guangzhou rail station, with no trains to take them to their destinations, no food, little water, and what might at best be referred to politely as primitive sanitary conditions. Unwilling to leave, they were also virtually impossible to sustain in situ. Troops and national political figures hurried to the scene to enforce order and plead for calm. Throughout the region, breakdowns that were different in detail but similar in overall pattern were taking place. Power outages were widespread and persistent – partly because icing caused breaks in power lines, but also partly because transport obstacles prevented repair efforts from moving rapidly to affected areas. With transport at a halt, coal supplies ran short at power stations; in the resulting power outages, coal became difficult to transport (on the newly converted electric train grid) until diesel-fuelled engines could be mobilised and assembled in the area (and, meanwhile, diesel fuel also became scarce).²

¹ The authors are the faculty Co-Directors of the Program on Crisis Leadership, a joint programme of the Ash Center for Democratic Governance and Innovation and the Taubman Center for State and Local Government at the John F. Kennedy School of Government at Harvard University, and faculty Co-Chairs of the Kennedy School's Leadership in Crises executive programme. We are indebted to Douglas C. Ahlers for inspiration, guidance, and technical knowledge about systems and system dynamics and for suggesting a number of important insights and to Arrietta Chakos, David Giles, and Jason Qian for research support, comments, and suggestions. This research was generously supported by Swiss Re. Any remaining errors, alas, were always and still are our own.

² Much of this description is drawn from an extended Program on Crisis Leadership case study by Jason Qian, currently in draft.

Why were the effects of the snowstorm – unusually severe, to be sure, but hardly cataclysmic – so widespread and profound? What turned a modestly novel moderate-sized event into a major, embarrassing, out-of-proportion, “landscape-scale” disaster?

The high interconnectivity
of a number of systems...

Simply put, *one thing led to another*. Fundamentally, the challenge of the South China snowstorm was not that the storm itself or its immediate effects were so severe – it was, instead, that the consequences pyramided on one another and reinforced one another, spiraling up to create, collectively, a collapse of the wider *system* of tightly interconnected utilities (power, water, transport, communications), economic activity (manufacturing, power generation, food distribution), social activity (using transport systems to journey home for the holidays) and governmental activity (transporting additional supplies and assistance to affected areas). Under normal conditions, these different parts of the larger system operate in reasonable harmony with one another, and the system exhibits some level of resilience, absorbing small shocks and perturbations without creating major discontinuities in services or activities.³ By contrast, when the repeated snow and icing conditions simultaneously affected a wide range of interconnected components of the utility and economic system, the resulting consequences fed on one another and pyramided – eventually pushing each other collectively past the capacity of the system to absorb the shifts out of its normal operating ranges. In short, the extended snow, ice, and cold had caused a system-level failure or “collapse” – the failure was no longer just of the individual system elements, but also of the network of components – that is, it was a failure of the system as a whole.

...can trigger sudden and
unexpected failures, to which
societies are becoming more
susceptible...

Events like the failure of interconnected elements of systems leading to wider system failure events – as in the example of the South China snowstorm – seem to be becoming more common, and we believe this is in fact a pronounced and important trend. We believe that there are strong forces in the normal and common ways that economic, financial, natural and man-made physical systems co-evolve in the modern world that make the prevalence of the conditions that lead to system-level failures more prevalent. To put it another way, the risk of system collapse is secularly increasing, and system collapse as a form of large-scale social hazard should be understood as an increasingly likely and profoundly important phenomenon that needs to be addressed through changes in system designs, through policy, and – since it constitutes a risk – arguably through the development of new approaches to defining and insuring the resulting risks. If this is correct, the implications are potentially both deep and wide.

...necessitating greater
understanding of such systemic
threats.

We will begin by defining more carefully the nature of system failures and the conditions that facilitate them (and, indeed, in many cases make them inevitable). We will then examine some examples of past system collapses and some possible system collapses in the future, using this as a lens through which to identify some of the forces that seem to be systematically increasing the prevalence of this phenomenon.⁴ We conclude with some preliminary thoughts on how we might seek to manage this rising form of significant social hazard.

³ Such systems can be described as having *stability* or as being “Lyapunov stable”.

⁴ The phenomenon we are describing is what Charles Perrow labelled a “system accident”. We will use the terms “system-level failure”, “system collapse”, and “system accident” more or less interchangeably.

The nature of system accidents

Systemic challenge is the product of subsystem interaction...

Large-scale disasters often involve circumstances where two or more phenomena interact negatively, reinforcing one another's negative consequences. A rainstorm might bring down power lines that halt pumps needed to avoid flooding; the resulting flood may increase damage to the electrical grid, accentuating damage to the pumping process and making it more difficult and more time-consuming to reset the elements of the system so that they are again operating within their normal ranges (and in harmony with one another). Generally speaking, we can define a "system challenge" as a situation in which a series of "subsystems" interact in ways that are harmful to one another, pushing each other away from their normal operating conditions. This can be caused by an external shock to one or more of the systems or by an "error" – a breakdown of one or more components of a subsystem that takes the subsystem outside the range in which it is supposed to operate – in one subsystem or in two or more subsystems at the same time. A "system accident" or "collapse" occurs when a challenge rises to the level of pushing one or more elements of the overall system beyond their design limits, resulting in breakdown.⁵

...which will, eventually, inevitably lead to system collapse.

The phenomenon of system breakdown has been widely studied both in practice and in the abstract, particularly in the field of "system dynamics", which is devoted to understanding the nature of flows and interactions among elements of systems with different design features, structures, control and feedback mechanisms, and degrees of component reliability. A particularly compelling and accessible description of these issues is provided in Charles Perrow's *Normal Accidents*.⁶ Perrow outlines the general characteristics of systems that can be shown mathematically to have a non-zero probability of experiencing a system collapse – and which, therefore, if they are operated for long enough, will *inevitably* produce a system accident (hence the use of the term "normal", indicating that [eventual] system collapse is the ordinary state of affairs in such a system). In addition to presenting these results in an abstract and general form, Perrow provides a wide array of examples of systems that exhibit the characteristics that make eventual collapse statistically unavoidable. Perrow's work builds on (his own and others') earlier theoretical research in system dynamics, and is also the source and inspiration of much of the technical work that has followed since.⁷

Systems are designed to work within a specific space...

What are the conditions that create the statistical certainty of system collapse in the long run? To describe these conditions we need first to specify a bit more precisely the ways in which systems are designed to operate. The "state" of a system or subsystem can be characterised by the status of its relevant features at any given moment (for example, in a car engine, its state variables include its revolutions per minute, temperature, power output, fuel consumption rate, lubrication status, and so on – a set of characteristics that are inter-related to one another and which jointly define all that is relevant about the system's operations). Correspondingly, the system's "state space" consists of the set of all possible combinations of the state variables. When the system is operating in some regions of the state space, it will exhibit high performance; when it occupies other regions, its performance will be lower; in still other regions it may cause damage to its components, so that it cannot easily be restored to the high-performance region.

⁵ Breakdown or failure can be due to either a low fault-tolerance (sudden failure when a breaking point is reached) or by a degradation of system performance past a lower-bound threshold of acceptable performance.

⁶ Charles Perrow, *Normal Accidents: Living with High-Risk Technologies* (Princeton, NJ: Princeton University Press, 1999). The authors refer to Perrow's pioneering work on normal accident theory throughout this paper.

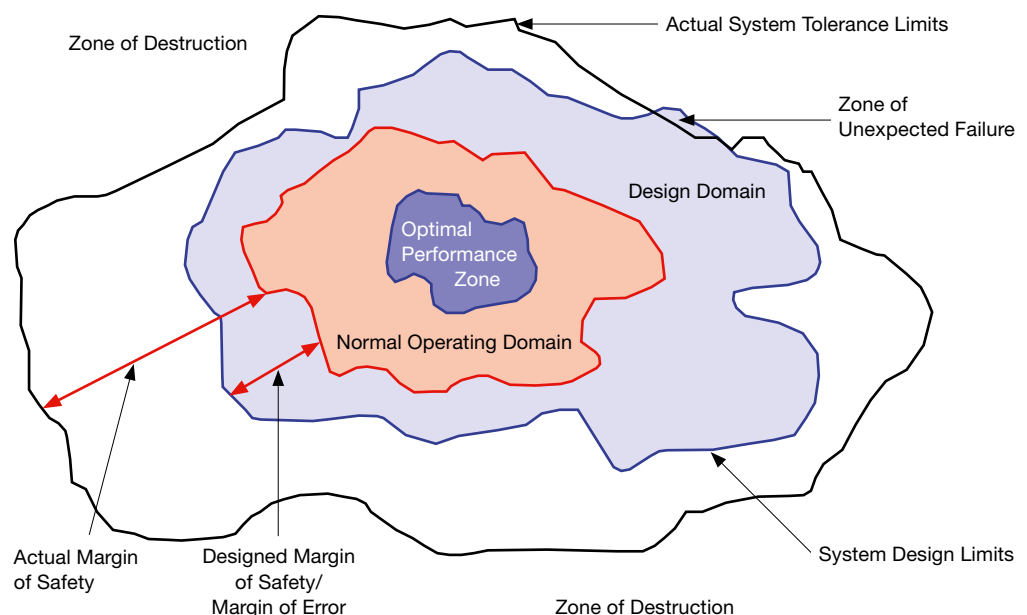
⁷ System Dynamics was originally developed by Jay W. Forrester. See: Jay Forrester, *Industrial Dynamics* (Cambridge, MA: MIT Press, 1961); and Jay Forrester, *Urban Dynamics* (Cambridge, MA: MIT Press, 1969).

...and will break down outside of their design limits.

Systems and subsystems are generally designed to operate within a “normal operating range” – that is, the variables describing the state of the system are supposed to vary (often in ways that are correlated with one another) within a limited domain of values. Performance may be better when the system is in some parts of its normal range than others, and the control processes are designed to keep it in the part of its normal range that is optimal for producing its intended outputs; but it is designed to operate successfully (and not to break down) so long as it stays within the normal boundaries. Indeed, systems are generally designed to continue to operate somewhat outside their normal ranges without resulting in catastrophic failure; while performance (understood as the cost-effective production of the outcomes that the system was designed to generate) may decline, and perhaps decline markedly, most systems can operate without immediate and complete destruction within a (wider) range of state variables outside the normal operating limits. We might refer to this broader range as constituting the “design limits” of the system. When systems are intentionally and intelligently designed, their engineers generally try to insure that they will not fail dramatically under any combination of state variables within their design limits, and they are generally (and professionally) conservative in making those calculations, so that the point at which significant damage to the system will occur actually lies somewhat beyond the design limits. If, however, the state variables of the system are pushed sufficiently far outside the design domain – past its “tolerance limits” – by definition the result will be breakdown and destruction.

Figure 1 illustrates the concepts of the optimal performance zone, the normal operating range, the design limits and the actual limits of the tolerance of the system (the boundary beyond which significant damage to the system will occur) in a notional system with two state variables (and thus a two-dimensional control space). As Figure 1 illustrates, in general the tolerance limits will lie outside the design limits – but if designers make errors in calculating how the system will behave, they may incorrectly estimate that the system is safe in areas where in fact it is in peril. Thus, when designers are not sufficiently cautious, there may be areas where the actual tolerance limits lie inside the calculated design limits, creating a zone of “unexpected failures”. Beyond the actual tolerance limits of the system, it will self-destruct.

Figure 1:
Notional illustration
of relationship between
performance, normal
operations and design
limits



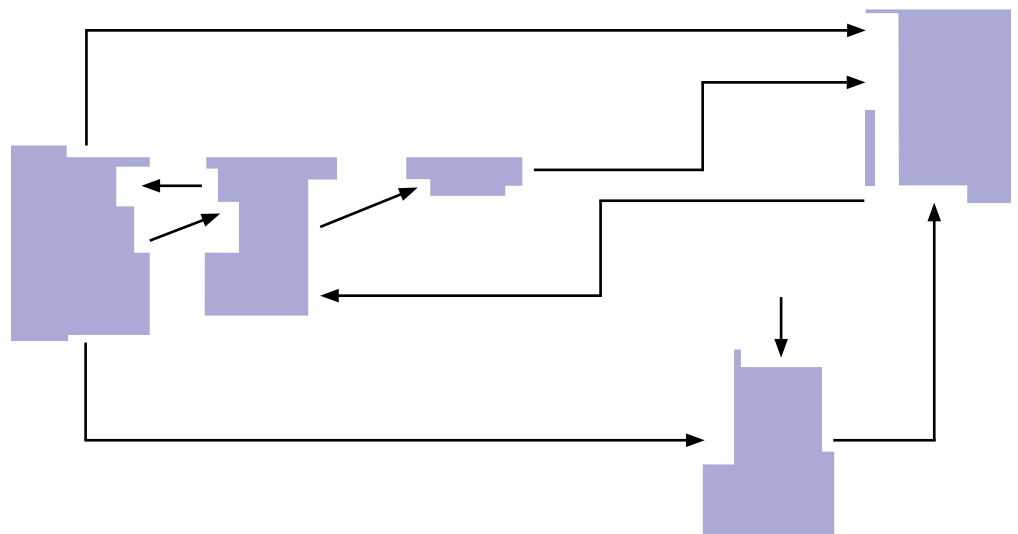
Systems can be characterised
in a number of ways...

Characterising systems in this way helps us to define better and to understand the nature of system accidents. As Perrow and others have detailed in an extensive literature providing mathematical proofs of the implications of the underlying characteristics, the key feature of a system subject to system collapse is a combination of complexity and interaction. Perrow details the requisite features of a system that will eventually experience a system accident:

- 1) **Multiple subsystems:** the system must consist of at least three subsystems;
- 2) **Complex interactions:** the subsystems must be interconnected to one another with multiple feedbacks that form loops (and thus allow for effects to cumulate);⁸
- 3) **Nonlinear interactions:** the outputs from one subsystem that are inputs to one or more other subsystems must be nonlinear – that is, a one-unit variation in the internal conditions within the subsystem that drive the output does not always result in the same amount of variation in the output;⁹ and
- 4) **Tight coupling:** the outputs of one module or subsystem flow directly and immediately into the next module as inputs (with no “buffer” to mediate the “shock” of an output change before it becomes an input change to the next module); and
- 5) **Imperfect reliability:** subsystem components are imperfect, so that eventually an error will occur in more than one module at the same time.

Figure 2 shows a pictorial illustration of a system that meets these criteria (so long as some of the interactions or feedback flows are nonlinear).

Figure 2:
Diagram of a system showing
multiple complex tight couplings
among subsystems



⁸ Perrow describes the complex interactions that will turn out to be problematic as “those of unfamiliar sequences, or unplanned and unexpected sequences, (that are) either not visible or not immediately comprehensible”. While Perrow does not specifically speak to this in *Normal Accidents*, complex systems derive much of the force of their complexity from their scale as a result of the square law of computation – that the number of interactions (or edges) in a system is the square of the objects (or nodes) in that system. The square law of computation was first articulated in G. M. Weinberg, *An Introduction to General Systems Thinking* (New York: Wiley-Interscience, 1975).

⁹ Technically, this means that if there is a set of internal variables within a subsystem, $x_1, x_2, x_3, \dots, x_n$, that drives an output of the module, y , where the output $y = f(x_1, x_2, x_3, \dots, x_n)$ is a function of the subsystem’s internal variables, then y does not vary along a straight line when at least one of the values $x_1, x_2, x_3, \dots, x_n$ are changed, but instead varies along a curve. This implies that for some input variable x_i , the amount by which y changes when x_i varies by one unit changes as the value of x_i changes – sometimes, the variation of the x_i s makes more of a difference than it does at other times, and this variability introduces a form of instability into the system.

...which provide indicators as to their vulnerability.

What Perrow and others have shown is that systems with these characteristics are vulnerable to – and, indeed, will inevitably generate (given a long enough operating period) – a system accident in which the system is pushed first outside of its ordinary operating limits and then beyond its collective design limits to a point where it will fail simultaneously and catastrophically as a system.

Complex interactions amplify errors in one subsystem...

While the proof that such an outcome is an inevitability is difficult and highly technical, the general idea behind system collapse and the way in which these characteristics will tend to generate system collapse is not difficult to discern. The first two conditions (multiplicity of subsystems and of interconnections or feedbacks between subsystems) jointly create a set of complex interactions that are often unknowable in advance and thus are unexpected when they occur. This is then accentuated by the nonlinearity condition. Once an error (condition 5) – or an external shock – enters the system, its consequences can flow in complex ways among modules, accumulating in feedback loops and encountering and perhaps being reinforced and amplified by other consequences generated by the same initial force, and thus growing and pushing the system farther from the center of its normal operating range.¹⁰

...a risk largely negated by more simple system constructions...

With simple interconnections, stable subsystems and one source of error, such a system might be manageable over a long period. It would be the easier to manage the more the flows of outputs from one module were only loosely coupled to the input to the next module – as, for example, when the output from one module flows into an inventory (a holding tank, of sorts) and the flow out of that tank is managed, so that a change on its input side is not instantly transmitted as a change in the output side that drives the next module. This might make it possible to manage it in a way that keeps the system as a whole from exhibiting system collapse. However, when the subsystems themselves have internal instabilities, when there are multiple sources of error flowing into the system simultaneously, when the interlinkages are complex – and, especially, when there are no buffer zones between modules to mediate the fluctuations in output signals from one before they become input signals to the next – the prospects for a chain reaction that pushes the system beyond its breaking point rises sharply.

...with clearer design limits and correction measures...

Very simple systems can be successfully operated within their design limits – and captured and either halted or corrected when they threaten to break through their design limits. By contrast, systems with a requisite level of complexity cannot, in principle, be managed always to stay permanently and reliably within their design limits. This is why system accidents are “normal”, and it is a fundamental characteristic of systems with the requisite form and level of complexity and interactivity.

¹⁰ Both positive and negative feedback loops can exist, with positive feedback loops tending to amplify and negative feedback loops tending to create binding constraints over time (and often over very short periods). See Lars Skyttner, *General Systems Theory: Ideas and Applications* (Singapore: World Scientific Press, 2001). Both positive and negative feedback loops can be disruptive, as amplification of an output can be destructive as input to another subsystem, just as constraint can restrict output flows that are needed to sustain a downstream tightly-coupled subsystem.

...that avoid the inevitability of collapse present in more complex systems.

System accidents pose real threats on a socially important scale. When we build systems of sufficient complexity, system accidents become inevitable. When the systems affected are large and important, the level of hazard and damage is correspondingly large. Yet, system collapses have another feature that multiplies their impacts – by their nature of having torn asunder the value-creating fabric for which the system was designed and built in the first place, *they are difficult to reconstitute*. Systems are a complex and often delicate ecology – that is part of what makes them vulnerable to system-level accidents, but it is also part of what guarantees that recovery from hazards of this kind may be long and difficult.

Examples of historical system accidents and the potential for future accidents

There are many systems – ranging from modest to large to very large in scale – that exhibit the characteristics of vulnerability to system accidents. We have seen several system collapses on very different scales that demonstrate the phenomenon and emphasise the wide range of scales on which it can operate. In addition to the South China snowstorm example described above, we will briefly outline three examples as an illustration.¹¹

Three Mile Island demonstrated key vulnerabilities to multiple systems failure...

Example 1: Three Mile Island. A widely-examined instance in which a system accident actually took place, detailed at length in Perrow's work, is the collapse of the nuclear-powered electricity generating system at Three Mile Island that occurred in March of 1979. Nuclear power plants have a number of subsystems (heat/steam generation, cooling, electric power generation from steam, control systems, safety and monitoring systems, and so on). There are many complex and nonlinear interactions among these "modules", resulting in feedback loops that interconnect the overall system in ways that make power plants an archetypal example of the principles of vulnerability to system-level accidents. Perrow and others have traced how a series of breakdowns (and errors by the operators) spun up from being a minor maintenance issue to being an actual and near-complete meltdown of the nuclear core at the heart of plant. Safety systems built into the plant were designed to capture and render harmless significant departures of the system from its ordinary operations, but in the event proved unable to rectify the rising tide of interactions that were making the system as a whole increasingly unstable and increasingly out of control. Indeed, the safety systems themselves contributed to the problems – or, at least, the operators thought they had. This resulted in the operators shutting off parts of the safety systems (including the emergency backup cooling system, at a time when the core was already in the process of overheating) – which further exacerbated the spiralling consequences of the event.

¹¹ In addition to the examples given here, elements of the Hurricane Katrina catastrophe can also be understood through this lens. For example, Leavitt and Kiefer offer an argument for how the levee failures in the immediate aftermath of the storm constitute a system accident in: William M. Leavitt and John J. Kiefer, "Infrastructure Interdependency and the Creation of a Normal Disaster: The Case of Hurricane Katrina and the City of New Orleans", *Public Works Management and Policy*, 10 (2006): 306–314.

...while the 2003 US power grid collapse involved multiple power providers...

Example 2: The Northeast power grid in August 2003. In the case of Three Mile Island, the system involved was a single power plant (and, actually, only half of it, as the second reactor at Three Mile Island was unaffected by the system collapse of its sister reactor). In August of 2003, the northeastern United States and southern Canada experienced a power grid collapse that plunged 50 million people into darkness – and, while in most places power was restored within 12 hours, in some parts of the affected area power was off for more than three days. The outage resulted from a series of anomalous flows of power that apparently originated in the electric grid in the Ohio River valley. Instead of being damped out (by automatic system monitoring, control and regulation devices, and vigilant operators), a combination of what apparently were operator errors together with unprecedented reversals of power flow through the grid resulted in an a spiral of consequences that literally shattered the grid – and which destroyed a sufficiently large number of components that reassembling the system into working order was very time-consuming. How long this took is still being debated; signs of difficulty appeared several hours before the collapse, but nearly all of the large-scale anomalies developed within the system in the course of the final 20 minutes before the collapse – and most of those actually arose within the last few seconds before the system blew itself up.

...with climate change as one of the most complex cases of systems interaction.

Example 3: Global climate change. The global ecological and climate system clearly exhibits the characteristics that dispose a system to the potential of system-level accidents (and some observers believe that we are in the early stages of what will become a catastrophic system collapse). Ecological systems by their nature involve multiple subsystems that are intimately interconnected with many complex linkages. Similarly, the climate system involves distinguishable components that interact with one another. Importantly, the two disparate systems of ecology and climate are themselves tightly bound together (and increasingly bound to the human industrial, agricultural, and commercial systems). Some climate changes can be self-reinforcing (as when warming melts snow and ice, reducing the earth's reflectivity and thus causing greater absorption of heat from the sun), but landscape-scale ecological effects can also affect climate (as when changes in average ambient temperature change the biomass carrying capacity of a forest region, reducing CO₂ absorption). While it is arguable whether the climate and ecological systems are currently in the process of generating a system collapse, we are certainly witnessing changes in those systems that are very large on an historical scale, and the intrinsic characteristics of these systems make large-scale accidents a plausible and therefore significant risk.

Complex systems interactions in very different scenarios have some common qualities...

These examples illustrate how prevalent system accidents already are – and they also indicate that other systems in our midst might be similarly vulnerable. For example, the South China snowstorm suggests that our general transport and food production and distribution systems might be vulnerable. Without doubt, they consist of multiple subsystems that are tightly bound to one another through multiple and often non-linear linkages. On an even larger scale, many of those who note that the global ecology and climate systems have these features view the ongoing evolution of global climate change as a (gradual-onset, but rapidly evolving) system collapse already in progress – and thus feel great urgency about finding ways to prevent or mitigate it.

...but some retain greater resilience than others.

Of course, not all complex systems exhibit these conditions, or accumulate them. Some systems have strong equilibrating mechanisms that push operations back towards the normal operating range (or towards the high performance zone) when they start to depart from those conditions. These systems exhibit stability – and they are therefore intrinsically more manageable, and are not the systems we need most to be concerned about. Our point here is not that all systems are intrinsically vulnerable, but that *some* are, and that there are systematic forces that tend to create (and to increase the prevalence of) vulnerable systems – which is the issue to which we now turn.

Forces that generate system vulnerabilities

Many system interactions evolved rather than being designed...

Where do these vulnerable systems – and system vulnerabilities – come from? Surely not from having been intentionally designed into any important systems that we utilise – in fact, to the contrary, most carefully-designed systems have been deliberately constructed so as to avoid the kinds of spiralling negative interactions that produce system accidents. *However, many of the systems we use (and inhabit) were not **designed** – they “formed.”* In other words, many of the systems that are likely to have the greatest effects on our future circumstances are not the product of a conscious, intentional, intelligent design process (which might have avoided building in the characteristics that generate system vulnerability, and presumably would have done so to the extent that those features were understood and avoidable). Instead, systems – the interactions and interlocking of destinies among different component subsystems – formed as a result of natural or human forces that brought or pushed them together, causing them to interact.

...as can be seen in ecological systems...

Ecological systems provide a good example of systems that “form”, driven by natural forces that end to create tight linkages. It is frequently to the evolutionary advantage of species, for example, to diversify their food sources – thus linking them to a larger collection of species, and increasing the extent to which effects in one part of the system will be transmitted (often rapidly) to others. The process of evolution leads life forms to “find” (through adaptation) new advantages, and while this will sometimes mean moving into a niche that is uncontested and unconnected to others, often it will mean forming additional links in an already strongly interconnected system. The intrinsic redundancy of such a system may contribute at the same time to its general resilience (in the face of small perturbations) and to its susceptibility (in the face of a larger disruption) to a cascading accident.

...which can be described as
“self organising” systems that
develop to a critical state...

Technically, the process of system “formation” from components is referred to as the creation of “self-organising” systems – distinguishing them from systems that were intentionally constructed (and, hopefully, designed intelligently). Such systems often exhibit a phenomenon called “self-organised criticality”.¹² It is helpful to describe this concept with reference to a simple physical example, and it is often illustrated by reference to the development of a pile of sand on a table. Consider a table with a funnel above it into which sand is poured at a steady rate, so that a pile of sand begins to form on the table top. Suppose that the important (“critical”) event in this system is defined as the shedding of sand off the edge of the table. At the outset, the pile grows without incident; the system is “subcritical” – it has not approached its critical state, where the important event will begin to occur. As the pile grows higher, it will also naturally spread out (in a way determined by what geologists refer to as sand’s characteristic “angle of repose”), which in turn is determined by the size, shape, uniformity, roughness and resulting frictional characteristics of the grains of sand) until its edge begins to approach the edge of the table. At this point, the system is becoming poised in its critical state – that is, it has now evolved to the point where its critical events will begin to occur.

...at which point vulnerabilities
can occur...

An important question now arises: what will be the nature of these critical events? Will sand pour at a constant rate off whichever edge of the table the pile first approaches? Or, instead, will sand cascade more episodically, in pulses, off the table? If it falls in pulses, will they be of more or less uniform size, or will there be a stable distribution of sizes? Will sand begin to fall off one edge, while the pile continues to grow in other directions? Will sand eventually begin to pour off more than one edge?

...bringing the system to a state
of supercriticality...

Interestingly, in this and in many systems like it, the answer is that the system will continue to accumulate “energy” (sand, in this case) and will come to exhibit a stable distribution of critical events of various sizes that nearly always follows a logarithmic curve. As the system is forming, the distribution of event sizes is not stable, but instead is evolving. The system has reached “maturity” – referred to as having achieved “supercriticality” – when the size distribution of critical events has stabilised, and the next “cascade” of sand off the edge of the table will behave as a random draw from the power distribution of sizes.

...at which point events will
occur...

An important implication of this (quite general) system phenomenon is that, once it has achieved its mature, supercritical state, *the system will generate critical events across a wide range of scales*, with many small events and some modest-sized events and – crucially – with low frequency but at least episodically, *very large events*.

...inevitably leading to system
accidents.

An interesting way of interpreting system accidents in the kinds of human systems we are considering here is to think of these formed, self-organised systems as evolving towards a point of supercriticality, at which we will observe critical events of all scales with a random but probabilistically predictable frequency. If we then define a system accident as a critical event beyond a specified scale – how large do the financial ripples have to be before we define an ongoing event as a financial crisis? – system accidents will be an inevitably recurring phenomenon. Viewed this way, the conditions outlined above as leading to system accidents can be seen as the conditions that generate (either self-organised or designed-in) supercriticality.

¹² This concept was originally developed and articulated by Chao Tang Bak and Kurt Wiesenfeld in “Self Organizing Criticality”, *Physical Review A*, Vol. 38, No. 1, July 1, 1988.

Forces that push human systems toward supercriticality

Both system complexity and tightness contribute to adverse events.

The question of what forces seem to be generating an increasing array of significant accidents in the systems that surround us thus becomes the question of what forces tend to bring systems towards and into a supercritical state. In both designed and self-organising human systems, the forces seem to be similar. We might divide them broadly into two types: first, there is a tendency for more complex linkages to form (or, in the case of designed systems, to be formed); second, there is a tendency to increase the “tightness” of the linkages between different parts of the system.

Complexity develops as additional linkages develop to successful systems...

Greater complexity may tend to arise over time because the additional linkages constitute ways to take advantage of the flow and activities of the system. In the example of global climate change discussed above, for example, evolution was observed to be a natural force that often generates additional linkages among species, thus increasing the interconnect- edness of the overall system. The same is true in economic systems – only here the actions of the agents are often conscious and intentional. Seeing advantages to connecting different aspects of commerce, economic agents create new links that facilitate valuable commercial activity in good times but that also enable the ripple effects that can tear such systems asunder in the face of significant simultaneous disruptions in component sub- systems. Information technology systems that enable “just in time” inventory methods in manufacturing, food distribution and other areas of economic life generate benefits to the agents that invent them and to many of the participants in the more complex system that results – but also may make that same system more susceptible to self-reinforcing destructive reverberations. Competitive forces (in ecology and in commerce) can often create self-organising pressures that cause system vulnerabilities to accumulate.

...and technology facilitates greater system interaction.

Greater complexity may also arise over time because it has become technologically more sustainable. In a world without computers, we could not possibly operate a structure as complex as the current air traffic control system; we are enabled to build more complex systems by the advent of new information management capacities. On the one hand, they allow us to construct and manage more complex systems that would be impossible (or would produce catastrophic levels of errors and collisions) in their absence. On the other hand, by enabling the construction of more complex and interdependent systems, they also create conditions that may lead inexorably to periodic system accidents.

Tight system coupling gains efficiency but reduces the buffer zones that protect against system accidents.

Tighter coupling may also tend to increase over time for “efficiency” reasons. What tight coupling means is that there is no buffer zone between the components of the system – and output from one module immediately becomes an input to the next. This is good – and efficient – in the sense that there are no inventories where costly resources are “parked” without providing direct benefits; resources generated by one module are immediately used in the next. The problem arises because this creates the potential for rapid transmission of errors, and thus instability – when one module goes out of its control space (and its outputs similarly depart from the expected range), the next module in line is immediately being driven by inputs that are out of the anticipated range – and it, too, is thus nearly immediately operating out of its control space as well. Reducing the vulnerability thus generated generally requires the construction of a “buffer” of some kind between the components. When module A goes out of control, the flow into the buffer is affected, but the flow out of the buffer can still be regulated, at least for a while, to stay in control – the level in the buffer rises (or falls), so the buffer is being pushed away from its normal state, but module B is not immediately affected.

Greater complexity and tightness brings systems interaction to the state of supercriticality.

This has the effect of delaying the transmission of the “error,” in effect isolating the error in module A (rather than transmitting it instantly to other modules), and giving system operators or participants (or the intrinsic or designed-in resilience within module A) a chance to rectify the challenge while it is still confined to one module (rather than allowing it to sweep across the whole system). However, such buffers constitute (and consume) real resources – they cost money, and “efficiency” thus often seems to call for reducing or eliminating them. They do not tangibly produce value – instead, they intangibly reduce risk – and as a result their value may be easy to overlook.¹³

All of these forces can be viewed as the natural result of powerful and systematic economic forces. The competition to create new opportunities tends to create additional linkages; the desire to take advantage of the benefits of greater complexity pushes the development of information and control technologies to enable the (temporary) management of more interdependent systems; the pressure to conserve scarce resources tends to push system designers, participants and engineers to see buffers as costly and superfluous, leading to tighter coupling within the system. Thus, in human systems driven by economic considerations – which is a very large class of human systems indeed – systematic economic forces drive both designed and self-organising systems towards being balanced on the point of supercriticality.

Social management of the risks of system accidents

How well prepared are we, as societies, to confront the rising level of social risk that this phenomenon is generating? Unfortunately, there is good reason to think that neither individuals, organisations nor governments are either very aware of or very well-designed to manage these risks in advance or to cope with their consequences when they arise.

Many complex systems are not systemically regulated.

First, since many of the systems that create large-scale social vulnerabilities are not comprehensively designed, but instead are at least partly self-organising, there is no natural regulatory process that encompasses them. A nuclear power plant is fully designed, and does operate within a nexus of defined authority (in the US, in the form of the Nuclear Regulatory Commission). However, there is no similar comprehensive design nor overall supervisor for the world food production and distribution system, nor for the world manufacturing system, nor for the world financial system.

¹³ We are using the term “buffer” here both broadly and loosely. There are, of course, mechanisms other than buffers (narrowly defined as inventories accumulated between the output side of one module and the input side of the next module to which it is linked) that can be used to regulate or mediate the relationships across a system link. The output from one module can be influenced (and, in the extreme, controlled) before it becomes an input to the next module by control gates, switches, impedance mechanisms, flow restrictors, check points, back-flow preventers, circuit breakers, and so on. For example, according to an analysis presented by Ivor van Heerden and Mike Bryan, the levee breaches in New Orleans were along drainage outflow canals and navigation canals where storm surge came back into the outflow canals; simple gates (backflow preventers) costing something in the range of USD 100–150 million have prevented this problem (Ivor van Heerden and Mike Bryan, *The Storm*; New York: Penguin Books, 2006). While such mechanisms can thus be very useful, we should note that the addition of these control devices constitutes yet another complexity in the system that, in addition to keeping it safe from some anomalous interactions, may also make it more vulnerable to others.

Individuals frequently fail to perceive the high degree of system interconnectivity...

Second, participants in systems often don't see what they are involved in as systems, and therefore may not be able (or even interested) to see the interdependencies (and to notice the attendant risks). Participants do not generally have transactions with a large fraction of a system – they tend to be engaged with one or a few components. Consumers of food, for example, interact almost exclusively with the retail end of the distribution system; by and large, they have little natural contact with even the wholesale system, or any of the other components that stand behind it; farmers deal with the other end of the chain (and with suppliers of seed and fertiliser), but see even the very next components down the line from their operation – the wholesale agricultural commodities purchasing and transport systems that buy and carry their products away – only in part and only briefly. Generally, there is little about participation in a complex system that systematically reveals the nature of the larger system – or that even invites interest in it.¹⁴

...or system vulnerability...

Third, there is widespread lack of understanding of the nature of system accidents, of the risks associated with them, and of the conditions that create vulnerability to them. In the absence of this understanding – and the ability of relevant, large-scale actors to be able to develop a broad, system-level perspective – it is difficult to take any significant steps to minimise the associated social hazards.

...for which governments can also be poorly prepared.

Fourth, large institution-regulating organisations – in a word, governments – do not always tend to think of the things they manage as systems, do not appear to be aware of the conditions that generate vulnerability, and may not have developed the instruments necessary to reduce the hazards that these conditions collectively produce.

System vulnerabilities may ultimately exceed government capacity.

Finally, many of the systems that exhibit the characteristics of vulnerability outlined here are of a scale that transcends existing government structures – as is perhaps best illustrated by the piecemeal and incompletely coordinated attempts to manage the recent (ongoing?) financial crisis and the attempts to coordinate reforms of the system. The financial system is global in scope, self-organising, and strongly driven by the economic forces that tend to push systems toward supercriticality; it was not comprehensively designed (and therefore can easily develop difficult-to-notice linkages that generate significant potential for instability and system-level failure); its current evolution and the development of new linkages is undertaken by self-interested agents who can't or don't see the larger system as a whole (and who might not care if they could or did); and it is not owned or overseen by any single (or even a well-organised and coordinated group of) regulatory overseers. It should be no great wonder, then, that it may have been (and may still be) self-organising itself into a supercritical state in which it is subject to system accidents.

Reducing the risks of system level accidents

What, then, can societies do to reduce the likelihood and cost of system accidents?

The analysis above suggests several possible (non-exclusive) approaches:

- 1) We can become more aware of the presence of complex, nonlinear, tightly-coupled systems – and more alert to their vulnerability and to the scale of potential losses should they be triggered;

¹⁴ Optimistically, however, there appears to be a growing public interest in where our food originates and how it is processed and delivered. Michael Pollan's work, *In Defense of Food: An Eater's Manifesto* (New York: The Penguin Press, 2008), and his other popular publications point to the growing general interest in healthy food and the "locavore" movement, which (at least locally) both simplifies the food system and brings people more directly into contact with the key elements of the system they are participating in.

- 2) Where potentially vulnerable systems have been identified, we can try to intervene (or induce others to intervene) to eliminate one or more of the preconditions to disaster through any of three broad approaches: (a) by improving diagnostic and control systems, which could allow us to keep some systems more reliably within desired tolerances (but we have to be careful that dependence on these more finely tuned control systems does not simply create an additional complexity that adds to vulnerability instead of resolving it); or (b) more commonly, by identifying areas in the system that are most likely to create or retransmit errors that could spin up into system accidents, and then isolating them through inserting buffer zones or other flow-control devices between them and the modules they are linked to; and/or (c) by directly simplifying systems by breaking them into a larger number of subsystems that are better isolated from one another.¹⁵ More generally, reducing system accident vulnerability means trying to “redesign” either comprehensively designed or self-organising systems so that they exhibit less complexity, have fewer linkages overall and fewer nonlinearities in particular, and have more buffering and controls between modules. The simpler systems thus developed may be more expensive to build and to operate in the short run, but they will be less prone to large-scale accidents because it is easier to isolate difficulties and anomalies within one or a small number of modules rather than having them rapidly transmitted throughout the system (so long as we engineer the interactions among them with appropriate controls and buffers); and
- 3) We can be more careful to recognise the possibility of large-scale system accidents, and can better prepare to respond to and recover from their correspondingly large-scale consequences.

Conclusion

Strong and durable forces (including most notably the evolution of technology and the increasing drive for short-run economic efficiency) are producing increasingly prevalent conditions for system-level collapses. Wise organisations will recognise this, identify the systems they are embedded in (or managing or overseeing) and are dependent upon, and will do what they can to prevent these hazards from eventuating. They will also organise themselves to be better able to respond to, and to be more resilient in the face of, the unavoidable systemic risks that remain.

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¹⁵ Here, the square law of complexity works in our favour; by creating a larger array of simpler subsystems, each component by itself becomes less internally complex; if we reduce the number of elements within a component by half, we have reduced its internal complexity by a factor of four – we wind up with a larger number of more manageable components. This process may, however, generate a larger number of interactions between the resulting larger number of subsystems, and in those interactions the square law is again acting against us – we need to be careful to engineer the external interactions between the larger number of system modules in a way that mediates the flows between them effectively.

The International Risk Governance Council's risk governance framework: Appropriate governance for ignored and emerging global risks

M. Granger Morgan, Christopher Bunting, Marie Valentine Florin – Risk governance concerns how public authorities, private businesses and ordinary people can collectively identify, assess and manage the risks they face. The International Risk Governance Council (IRGC) has developed two methodological approaches to risk governance, in particular for systemic risks. Together, they provide a holistic and integrative approach to risk handling.

Managing change includes the management of risk.

Risk is ubiquitous and accompanies all change. It is a permanent and important part of life and the willingness and capacity to take and accept risk is crucial for achieving social and economic development and introducing new technologies. Many risks, and in particular those arising from emerging technologies, are accompanied by potential benefits and opportunities. The challenge of better risk governance lies here: to enable societies to benefit from change while minimising the negative consequences of associated risks.

IRGC's first approach is its Risk Governance Framework.

The first of the two approaches offered by IRGC is its Risk Governance Framework. The framework's purpose is to help policymakers, regulators, risk assessors and risk managers both understand the concept of risk governance and apply it to their handling of risks. IRGC's framework builds on the classical distinction between risk assessment (generation of knowledge) and risk management (decision and implementation). It adds a pre-assessment phase (to properly frame a problem and how best to handle it). It includes a characterisation and evaluation phase, in which scientific facts regarding the risk are combined with a value-based judgement of the risk's acceptability. IRGC's framework has communication as its central element, and it includes guidance for stakeholder involvement in risk decision-making. A detailed description of the framework was published in IRGC's White Paper "Risk Governance – Towards an Integrative Approach" in 2005.¹

The need to address recurring risk governance deficits

Risk governance deficits hinder fair and efficient risk governance...

In each project in which IRGC has looked at the governance of a specific risk, a key question has been: What are the deficits in the risk governance process and structures that require improvements? As more topic-specific projects have been undertaken and completed, the question has increasingly been asked. IRGC's project work, therefore, laid the foundation for a recently-completed project which has sought to further explore the general concept of risk governance deficits. The conceptualisation of risk governance deficits represents IRGC's second approach to risk governance.

IRGC defines risk governance deficits as deficiencies (where elements are lacking) or failures (where actions are not taken or prove unsuccessful) in risk governance structures and processes. They hinder a fair and efficient risk governance process. Their impact is to increase the severity and cost – both financial and in terms of life, health and harm to the environment – of a risk.

¹ "Risk Governance – Towards an Integrative Approach", White Paper No 1, IRGC, Geneva, 2005. The full text of this document, as well as an introduction to it, can be downloaded from www.irgc.org

...and have recurred over time.

Through a careful review of the risk literature, and in a series of workshops with risk experts and practitioners, IRGC has identified a number of common deficits in risk governance (Table 1).² These deficits have recurred over time and have affected risk governance in many types of private and public organisations, and for different types of risks. While deficits may be relevant for both simple and systemic risks, IRGC has focused on the latter. This is because systemic risks – defined as those risks that affect the functionality of systems upon which society depends and that have impacts beyond their geographic and sector origins – provide a greater challenge for risk governance and thus greater scope for the occurrence of deficits.

In the remainder of this section we elaborate on several of these common deficits.

Table 1:
Risk governance deficits

A: Assessing and understanding risks	
Gathering and interpreting knowledge	A1: Early warning systems
	A2: Factual knowledge about risks
	A3: Perceptions of risk, including their determinants and consequences
Dealing with disputed or potentially biased or subjective knowledge	A4: Stakeholder involvement
	A5: Evaluating the acceptability of the risk
	A6: Misrepresenting information about risk
Dealing with knowledge related to systems and their complexity	A7: Understanding complex systems
	A8: Recognising fundamental or rapid changes in systems
	A9: The use of formal models
Knowledge and understanding are never complete or adequate	A10: Assessing potential surprises
B: Managing risks	
Preparing and setting risk management strategies and policies	B2: Designing effective risk management strategies
	B3: Considering a reasonable range of risk management options
	B4: Designing efficient and equitable risk management policies
	B6: Anticipating side effects of risk management
	B7: Reconciling time horizons
	B8: Balancing transparency and confidentiality
Formulating responses, resolving conflicts and deciding to act	B1: Responding to early warnings
	B11: Dealing with common problems and externalities
	B12: Managing conflicts of interests, beliefs, values and ideologies
Developing organisational capacities for responding and monitoring	B13: Acting in the face of the unexpected
	B5: Implementing and enforcing risk management decisions
	B9: Organisational capacity
	B10: Dealing with dispersed responsibilities

² The IRGC report “Risk Governance Deficits” was published in October 2009.

A. Deficits related to assessing and understanding risks

The first set of deficits relates to risk assessment...

This first set of deficits relates to the collection and development of knowledge and understanding and to the evaluation of risks, and thus affects the decisions that will be taken for managing the risks. Increasingly dense and rapid networks in which the consequences of an action can be difficult to predict add a systemic dimension to the risks to which many sectors of society or the economy may be exposed. Under such circumstances, risk assessment becomes much more challenging and a number of important knowledge-related governance deficits can occur.

Gathering and interpreting knowledge about risks

...and includes incomplete knowledge...

Sometimes risk decision-makers may possess **inadequate factual knowledge (A2)** to conduct a robust risk assessment. This could be because there are gaps in scientific knowledge (for example due to insufficient research funding or misdirected efforts). It could also result from misinterpretation or flawed analysis of information, or a failure to verify the quality of the data or to appreciate its associated uncertainty. Poor factual knowledge about risk is exemplified by controversies over radio-frequency electromagnetic fields. The spread of mobile telephones has, for example, increased our exposure to these fields but our knowledge of the potential risks is still uncertain. In particular, elevated cancer risks have neither been proven nor ruled out by the evidence to date.

...failure to analyse or appreciate different risk perceptions...

Even when a risk is apparent, stakeholders may nevertheless disagree on its importance. Citizens, managers, politicians and others have their own interests, values and ways of thinking about things. Perceived risks can be very different from scientifically-derived estimates and differences in risk perception can vary between societal groups or even countries. For example, because Europeans have tended to worry more about climate change than Americans, but less about the local health impacts of fine particle air pollution, emission standards from fuel efficient diesel vehicles have been lower in Europe than in the United States. **The omission of (or use of erroneous) knowledge related to the public's risk perceptions and concerns (A3)** can mislead risk decision-makers.

Dealing with disputed, potentially biased or subjective knowledge

...value-judgements of risk...

Risk acceptability is an issue where value-judgements and perceptions play a central role. Gathering knowledge of risk acceptability is a necessary part of sound risk governance and a logical follow-on from gathering knowledge of public risk perceptions. This means **considering and developing an understanding of the underlying variables that influence public acceptance and risk appetite (A5)**. Such variables include: whether a risk is incurred voluntarily (eg skiing); whether it is in part controllable by personal action (eg driving a car); or whether it disproportionately affects vulnerable subpopulations (eg the poor or children). Objections to genetically modified (GM) food or stem cell technologies show that aversion to risk may be based more on beliefs than on scientific facts. In Europe these objections have been so strong that the regulation of GM foods can be described as being based more on public perceptions than on the results of scientific assessment.

Dealing with knowledge related to systems and their complexity

...and the systemic complexity of many risks.

Risk assessment is a difficult task when it relates to complex systems, because these systems have many different components, these components form interdependent sub-systems, and it is very difficult to identify or quantify the causal links between them. It follows that, if interactions between components are not well understood, it is hard to assess the probability and consequences of a risk being realised. **Risk practitioners must appreciate the consequences and limitations of complexity (A7)**, understand the possibility of unforeseeable interactions and aim to assess the multiple dimensions of systemic risks as best they can. A case in point is the Barents Sea fishery. Prior to its sudden collapse in the 1980s nobody had realised (or taken into account when setting fishing quotas) the complexity of the marine ecosystems involved. The role of local herring as predators of capelin was ignored until changed environmental conditions brought about a large growth in the numbers of herring, leading to a devastating collapse in capelin numbers. This in turn meant a large reduction in other species, including sea mammals, fish and birds.

B. Deficits related to managing risks

The deficits in this sphere concern the acceptance of responsibility and the taking of action in order to reduce, mitigate or avoid the risk.

Preparing and setting risk management strategies and policies

Setting goals and strategies to achieve them is necessary in managing risk...

Deficits may derive from failures or deficiencies on the part of risk decision-makers to **set goals, develop strategies to reach them, and make plans to implement the strategies (B2)**. While this seems straightforward, it is not always easy to achieve – especially when dealing with systemic risks in complex systems. Often, there will be more than one objective for a risk management policy, in which case trade-offs must be carefully considered. The United Kingdom government's failure to enact efficient policies to stop the transmission of BSE was largely caused by inadequate balancing of dual objectives – to protect both public health and industrial interests. In this instance, too great a trade-off was made in favour of industry. Regulations imposed on the meat industry were not as stringent as they should have been, and this ended up costing money as well as lives: an example of how inefficient regulation can harm the regulated industry as well as the intended beneficiaries.

...the potential externalities of strategies also have to be recognised...

However, even when a risk management policy is effective, efficient and equitable, it can still have unintended side-effects. For this reason, **efforts must be made to anticipate the consequences (particularly negative side-effects) of a risk management decision (B6)**. For example, biofuel policies designed to strengthen energy security by promoting production of corn-based ethanol may, foreseeably, have negative impacts elsewhere, such as on food prices, soil degradation or indirect greenhouse gas emissions. Moreover, because not all outcomes can be anticipated, monitoring the effects of actions is equally important: contingency plans should be prepared for use in the event that monitoring reveals risk management measures to be failing or causing negative impacts.

There have been risk management success stories, such as with CFCs.

There are examples of risks that have been effectively identified, managed and contained due to successful monitoring. One example is the depletion of the ozone layer: when it was discovered in 1974 that anthropogenic emissions of chlorofluorocarbons (CFCs) were causing the depletion of stratospheric ozone, efforts to monitor these emission levels and rates of ozone loss and recovery were quickly mounted. The signing of the Montreal Protocol in 1987 led to the implementation of risk management measures (bans and phasing out of ozone-depleting substances), the effects of which have been consistently monitored ever since, with promising results.

Formulating responses, resolving conflicts and deciding to act

Intelligence and the warning of risks must be effectively filtered...

When decision-makers receive advance warning of a risk, they must decide whether this risk is a priority and what level of response, if any, it deserves. A deficit can occur at this level if, for example, **early warnings are picked up by analysts, but never effectively communicated to or internalised by the decision-makers (B1)** who could act on them. For warnings that do get through, any ambiguity in the warning may turn into a reason for inaction if the information is inconvenient or jeopardises particular interests. Under-reaction may also result from the way the risk is prioritised. One such case was Hurricane Katrina, which devastated New Orleans in 2005. It had long been appreciated that the city was in danger, but Louisiana never received enough money for full-scale evacuation exercises or renovation of flood defences.

On the other hand, over-reaction to a possible hazard may impel policymakers towards over-zealous regulation or produce public panic. Thus children in the United Kingdom were put at risk in and after 1998 by inaccurate claims that the standard inoculation against measles, mumps and rubella might be a risk factor for autism.

...to allow their effective and flexible management.

Some risks may be so difficult to deal with that any kind of 'standard' response will be inadequate. Risk managers must be able to recognise when they are faced with such risks and to acknowledge that even systems which work well today may not deal well with unexpected and unforeseeable future changes in the risk landscape. **What risk managers then need are techniques that allow them to build the flexibility and capacity to respond to unexpected events (B13)** (Black Swans), and to think about risks in an unconventional way. Organisations, in turn, need ways to reward and listen to people with unfashionable views instead of marginalising them. Systems which have resilience and redundancy built into them will react better to unexpected surprises than leaner systems, giving the people who run them time to adapt to new circumstances.

Developing organisational capacities for responding and monitoring

Preparations, strategies and plans of action aside, at the end of the day it is the execution of these plans that will make the difference in mitigating risk. For this, decision-making power, resources and coordination are prerequisites.

A risk culture is also vital.

For most organisations, risk management is only one of many business priorities, so they may not necessarily have **an adequately developed risk culture or the organisational capacity (assets, skills and capabilities)** for managing all the risks to which they are exposed (B9). Even organisations which are focussed on risk management can be found lacking in organisational capabilities – the US Federal Emergency Management Agency was suffering serious personnel and budget shortages at the time when Hurricane Katrina hit, thus making its preparation for and response to the disaster severely inadequate.

How IRGC's risk governance concepts and approaches can inform the handling of specific emerging risks

IRGC has suggested measures for a number of emerging risks...

IRGC's work also involves looking at specific underappreciated or emerging risk issues whose mitigation or management would benefit from improvements in associated risk governance structures and processes. These include nanotechnology, synthetic biology, carbon capture and deep geological carbon sequestration (CCS) and bioenergy. Each of them presents new governance challenges, including a range of risks for which there is often great scientific uncertainty.

...where risk perception may run differently to scientific evidence.

New technological developments are frequently the subject of contentious debate and thus difficult for policymakers to address. One common element among all the examples addressed by IRGC is that the perception of risk may exceed the scientific evidence of risk. Others are that trade-offs need to be made between various risks and that secondary benefits or risks may be overlooked. It is difficult to balance in a scientific and acceptable manner all the potential benefits and risks related to products deriving from these technologies and their application.

Nanotechnology, for example, is an enabling technology which is already influencing the composition and utility of hundreds of products in everyday use. These include paints, clothing, cosmetics and foods, all of which have well-established worker and product safety regulatory structures and processes. Most regulatory processes do not require that the ingredient or product be subject to a new approval process and there have, to date, been few published results of risk assessments of the reformulated products or their nanoscale ingredients. That materials are known to behave differently at the nanoscale raises questions regarding potentially adverse effects (the positive aspects are, naturally, what leads manufacturers to use them). The result has been significant public debate, prompted in part by some NGOs calling for moratoria on commercial release. IRGC recommended that the most urgent need was for a greater emphasis on developing risk-related factual knowledge.

Similar issues to those raised in the past by genetic engineering are currently being raised by **synthetic biology**. Both involve the deliberate manipulation of genetic material. When this is done to develop new drugs, there appears to be a perception of no risk by the public. Perceptions are different in the case of genetically modified foods. Synthetic biology differs from genetic engineering by focusing on the development and use of standardised genetic sequences or “parts”, using the tools of biological engineering. Because this field is evolving so rapidly, a conventional strategy of risk assessment and risk management is seriously limited by profound uncertainty, both of potential benefits and potential risks. By deliberately forcing public perception of risk to be taken into account, risk managers are made aware of the need to manage public expectations and concerns: synthetic biology is raising issues for which merely stating the scientific evidence will not suffice.

Carbon capture and deep geological sequestration (CCS) is another new technology with some degree of uncertainty. It is difficult to argue against the fact that CCS currently offers one of the best available means of reducing CO₂ emissions from fossil-fired electricity generation plants. Scientists can model the possible behaviour of captured CO₂ underground, but this must be accompanied by large-scale commercial experiments, monitoring of effects, adequate long-term liability regimes and economic support. This is what IRGC has recommended, adding that – because of the need to maximise learning from these experiments – the knowledge learned from them should be shared internationally, under appropriate technology transfer agreements.

Bioenergy is already in wide use around the world. One form of bioenergy, biofuels for transportation, has raised interest, mainly from governments, to support energy security and the agricultural sector, but also from industry and some parts of the public. However, the development of biofuels has also raised concerns, including the possibility that the environmental and CO₂ balance may not be advantageous, that food security may be harmed, and that market pressures may accelerate the destruction of forest lands. Central to the governance of the risks and opportunities of bioenergy is the need to better assess and resolve trade-offs.

Further details of all these policy recommendations can be found in publications downloadable from the IRGC website.³

³ IRGC projects, <http://www.irgc.org/Publications.html>

Conclusion

Traditional approaches to risk often treat problems separately, developing a risk assessment of a specific hazard in a specific circumstance and location. One of the more significant achievements of IRGC, and its approach to risk governance, is that it moves beyond this and looks at risk in a broader context. IRGC's recommendations must be put in the specific context of the organisations that apply them – its target audience is global, and decision-makers can adapt IRGC's guidelines to their own needs in order for them to become actionable – but their broad view means that all those who are collectively responsible for governing the risks addressed by IRGC know that they are part of a global governance process that needs to act cohesively if these risks are to be effectively addressed.

Real-world policymaking often requires difficult trade-offs. Choices have to be made. The fact that IRGC's framework is now used widely in major EU-funded research projects and even by some governments as a way to develop their own policy recommendations, suggests that it is proving useful beyond IRGC's own work as a tool to improve the governance of ignored or emerging risks.

We hope that by identifying and describing risk governance deficits and their impacts IRGC will help risk assessors, risk managers, regulators and policymakers to recognise and remedy deficits in the risk governance processes of which they are a part. Risk is ubiquitous and new risks will continue to emerge. It is our hope that the approaches developed by IRGC will improve their governance.

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IRGC is an independent organisation whose purpose is to help the understanding and management of global risks that impact on human health and safety, the environment, the economy and society.

Broad horizons: The Global Risk Report and a holistic risk assessment

Sheana Tambourgi – Regulatory authorities are increasingly urging the entities they supervise to take a broader and more holistic view of the risks they face. The Global Risk Report is the most prominent publication attempting to capture not only a snapshot of the current global risk landscape, but also the dynamism with which different risks are evolving. The following article explains the underlying concept and methodology behind the Global Risk Report.

1. Gaining a holistic overview

One lesson of the 2008 financial crisis was the interconnectivity of risk...

Risk interconnectivity is an increasingly recognised phenomenon. This was no more the case than at the height of the global economic crisis in 2008–09. The falling US housing market dragged with it not only US lenders but banks across the world. Much of these losses were sunk in the murky and opaque world of asset backed securities, the very capital market instruments that should have dispersed risk. Uncertain of the balance sheet of other financial institutions, counterparty risk suddenly shot up, causing in its wake a massive global liquidity crunch, as banks refused to lend to each other.

... a trend highlighted in the first 2005 Global Risk Report.

One of the lessons for regulators from the 2008 financial crisis will be that risk was treated in too compartmental a fashion prior to the liquidity crunch. Too much attention was spent on box checking individual risks and too little on gaining a holistic and all encompassing risk picture. The recognition of the interconnectivity of risk is, however, not a new phenomenon. It had been noted as a growing trend by the World Economic Forum (WEF) at its Davos meetings from the 1990s onwards. In 2004, the WEF chose to react to growing concern with the creation of its Global Risk Network.

The Global Risk Network

The Global Risk Report is constructed upon the extensive Global Risk Network.

The Global Risk Network draws on risk experts from business, academia and civil society. The Global Risk Network is based on diverse members from the WEF Global Agenda Councils. The Global Agenda Councils address key challenges in over 70 areas of world affairs. These challenges range from sustainability to social welfare, from security concerns to building effective institutions. Made up of 15–20 leaders, each Council focuses on its particular area of expertise and works with other Councils to address common and related concerns.

The aim of the Global Risk Network is to (i) identify and assess the potential impact of select global risks on the global economy, the business community and the global society at large; (ii) study the links and interconnections between these risks; and (iii) highlight examples of multistakeholder risk mitigation strategies.

Alongside helping to shape the agenda for the WEF Annual Meeting in Davos, the Risk Network provides the basis for the Global Risk Report.

Global Risk Report

The Report highlights the increasingly integrated nature of risk...

The first Global Risk Report was published in 2005. The Global Risk Report for the first time attempted to place major global risks within a single analytical framework. The WEF has subsequently published the Global Risk Report on an annual basis.

The Report focuses on “global risks”. These are marked by uncertainty, high interdependence, sharp discontinuities and non-linearity and require a multi-stakeholder approach for mitigation. These risks can be strategic, exogenous or systemic, as well as non-business risks that affect businesses.

...forming an analytical framework for risk managers and decision takers.

The objective of the Global Risk Report is to raise awareness and offer a framework for decision-makers to appraise risks in an integrated manner. It stresses the importance of taking a longer-term approach than usually encouraged by electoral cycles or indeed financial reporting and executive tenure. By taking the ten-year perspective, the experts who contribute to the work of the Global Risk Network focus on the context in which strategies and policies are formed and decisions taken to manage, rather than react to risks.

The Global Risk Report process thus illustrates the Global Risk Network’s approach to achieving its main aims.

2. Risk identification, risk assessment and study of links and interconnections

The Report is based on survey data...

The Global Risk Report is based on survey data from the Global Risks Perception Survey. This web-based survey was completed over the third quarter of 2009 by over 200 experts, business leaders and policy makers from the Forum’s and the Report partners’ networks, as well as members of the Forum’s Global Agenda Councils. The Global Risks Perception Survey assesses how respondents perceive a selection of global risks tracked by the Global Risk Network. For each risk respondents are asked to select three other risks from the taxonomy of global risk that they consider are the most connected to the risk in question. The aim is not to determine causal relationships among the risks or identify drivers and consequences, but rather to determine the number and strength of interconnections between different risks.

...from a wide and diverse correspondence...

By consulting this group of experts and academics across the world throughout the year and relaying their findings in this annual report, Global Risks 2010 seeks to provide political and business leaders with a framework for further discussion of a risk landscape that is ever more complex and urges a consideration of the longer term global implications of risks in areas beyond their immediate effects.

The surveys are not open. Risk categories within them are predefined. The criteria for global risks have been set as follows:

- Global scope: To be considered global, a risk should have the potential to affect no less than three world regions in at least two different continents. While these risks may have regional or even local origin, their impact can potentially be felt globally.
- Cross industry relevance: The risk has to affect three or more industries.
- Uncertainty: There is uncertainty about how the risk manifests itself within ten years combined with uncertainty about the magnitude of its impact (assessed in terms of likelihood and severity).
- Economic impact: The risk has the potential to cause economic damage of USD 10 billion or more.
- Multi-stakeholder approach: The complexity of the risk both in terms of its effects and its drivers as well as its interlinkages with other risks requires a multi-stakeholder approach for its mitigation.

This results in the taxonomy of global risks. The risks are classified in five domains: economic, geopolitical, environmental, societal and technological risks.

...with a subjective and forward looking outlook.

The risks are assessed over a ten-year duration. Not only are risks assessed as to their potential impact and likelihood, they are also judged as to their potential interconnectivity. The result is that the survey is subjective and forward-looking. Although less grounded in hard numbers than other risk surveys, it also benefits from not being bound to past historical trends; as has been graphically demonstrated recently, past performance is no guarantee of future outcomes. Moreover, the subjectivity highlights those areas which are the current focus of debate among policy-makers and other stakeholders.

Mapping the risk

The Report seeks to estimate both the likelihood and impact of risk...

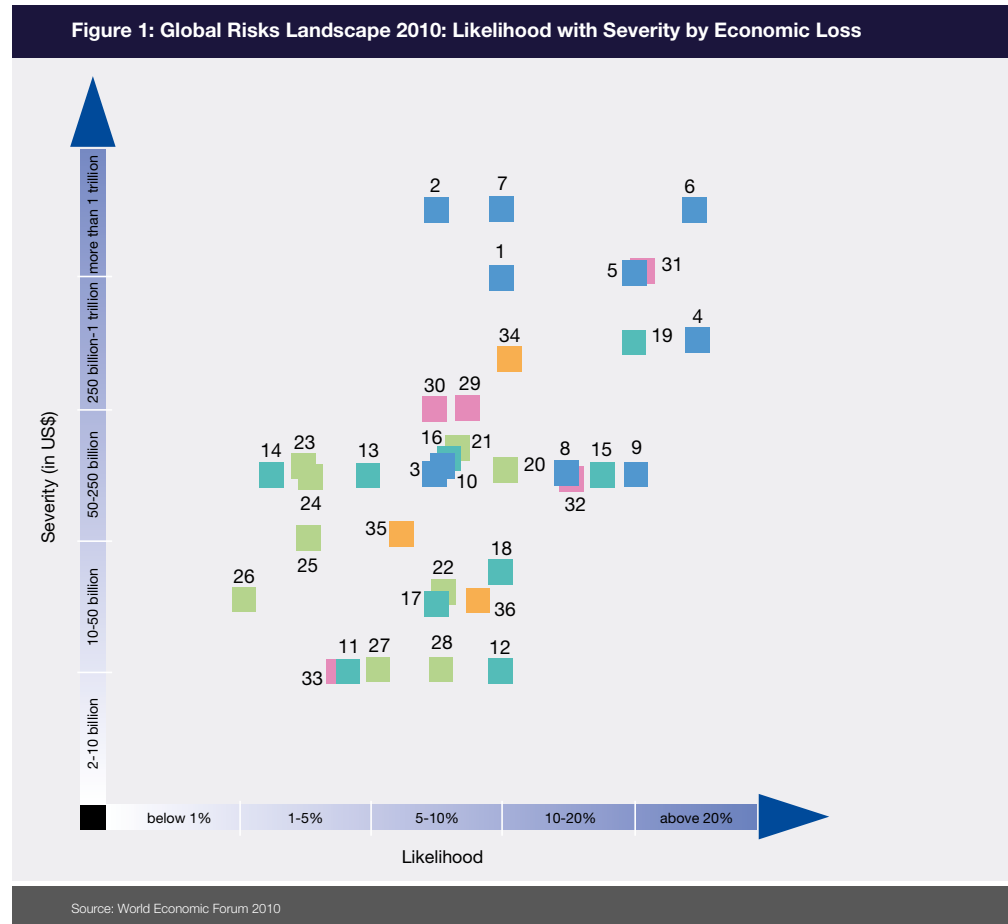
The Global Risk Report presents risk in two key dimensions. The first is by likelihood and severity of an event. This is captured in the Global Risks Landscape. The predefined risk categories of the 2009 risk map included economic risk factors, geopolitical factors, environmental factors, societal factors (including health) and technological factors. Likelihoods of events occurring are measured in percentage terms; while the severity of potential events is measured in potential dollar losses.

The Global Risks Landscape also captures a dynamism from the previous year. Risk categories can change and new risks can be included. A comparison can be made with the data from the previous year, which allows a clear view as to increases and decreases in perceived risk. This change can be measured both in terms of severity and in terms of economic loss.

...together with the interconnectivity of the particular risk.

The second key figure within the Global Risk Report is the Risks Interconnection Map. The map details (through the survey data) the interconnectedness of the different risk categories. Risks are linked through interconnectors; the thicker the connections, the greater the potential impact of one event on another. Thus, for example, a major energy shock would have repercussions on a number of risk categories, such as asset prices, the value of the dollar, food prices, protectionism and many others.

Figure 1:
Global Risks Landscape 2010 –
Likelihood with severity by
economic loss



Economic Risks

- 1 Food price volatility
- 2 Oil price spikes
- 3 Major Fall in the US \$
- 4 Slowing Chinese economy (<6%)
- 5 Fiscal crises
- 6 Asset price collapse
- 7 Retrenchment from globalization (developed)
- 8 Retrenchment from globalization (emerging)
- 9 Burden of regulation
- 10 Underinvestment in infrastructure

Geopolitical Risks

- 11 International terrorism
- 12 Nuclear proliferation
- 13 Iran
- 14 North Korea
- 15 Afghanistan instability
- 16 Transnational crime and corruption
- 17 Israel-Palestine
- 18 Iraq
- 19 Global governance gaps

Environmental Risks

- 20 Extreme weather
- 21 Droughts and desertification
- 22 Water scarcity
- 23 NatCat: Cyclone
- 24 NatCat: Earthquake
- 25 NatCat: Inland flooding
- 26 NatCat: Coastal flooding
- 27 Air pollution
- 28 Biodiversity loss

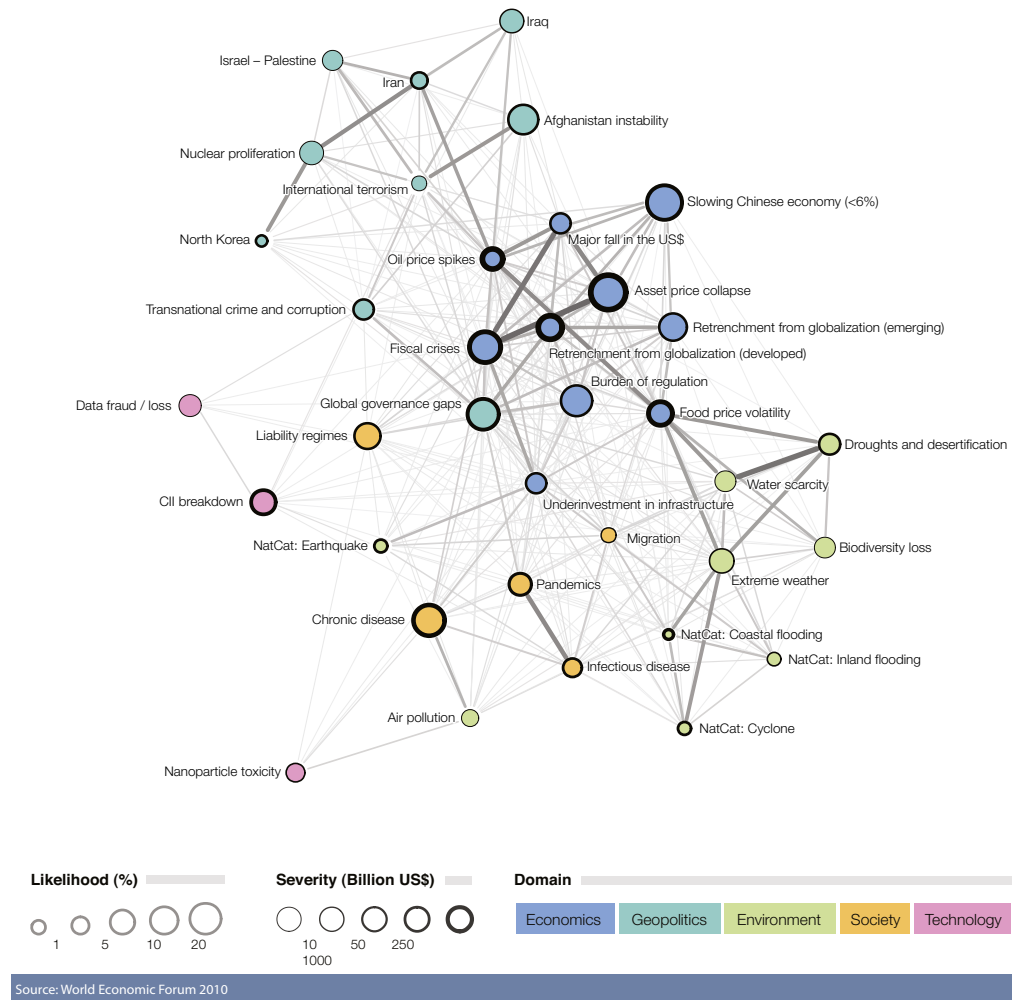
Societal Risks

- 29 Pandemic
- 30 Infectious diseases
- 31 Chronic diseases
- 32 Liability regimes
- 33 Migration

Technological Risks

- 34 Critical information infrastructure (CII) breakdown
- 35 Nanoparticle toxicity
- 36 Data fraud/loss

Figure 2:
Risks Interconnection Map (RIM)
2010



Some results – Global Risk Report 2010

After the shock to the global financial system and world economy in 2008, 2009 was a year of appraisal and adjustment. The risk landscape that this report has explored over the past five years has in fact changed remarkably little, though the risk set has expanded. What has changed dramatically is the level of recognition that global risks, like the world, are now tightly interconnected and that shocks and vulnerabilities are truly global, even if the impact and response can still differ at the “local” level.

Key themes in the 2010 Report are interconnectivity, creeping risks, and global governance gaps.

Three themes provide the backdrop to the 2010 Report. In the first theme, interconnections among risks mean a higher level of systemic risk than ever before and thus a greater need for an integrated and more systemic approach to risk management and response. Second, while sudden shocks can have a huge impact, be they serious geopolitical incidents, terrorist attacks or natural catastrophes, the biggest risks facing the world today may be from slow failures or creeping risks. These are risks linked to large shifts that will roll out over many years, even decades, and which are sometimes met with complacency because they are seen as distant threats.

For example, global population growth (with parts of the world ageing, and others with a youth bulge), crossed with rapidly changing consumption patterns have implications for resources, climate change, health and fiscal policy. The emergence of multiple poles of economic and geopolitical influence is another shift. At the same time two nations, China and the US, will probably play a determining role through their choice of consumption and savings paths. Finally, the third theme picks up the discussion of global governance gaps as featured in the 2009 report. In light of the ongoing short-term pressures on governments, businesses and individuals, can the necessary rethink and reform of global governance be achieved across the range of issues where it is required? Improved coordination on macroprudential supervision, effective climate and energy policies, and new mechanisms to protect resources and security are all key to reducing vulnerability and risk.

The 2010 Report further highlights risks exacerbated by the recession...

The 2010 Report considers two sets of risks, all of which are linked by their potential for wider systemic impact and by the fact that they are strongly linked to a number of bigger trends. Firstly, there are risks which feature highly on the risk landscape and that predated the recession but have been exacerbated by its impact. These include: fiscal crises and the social and political implications of high unemployment; underinvestment in infrastructure in both developed and emerging markets; and chronic disease. The report also notes how concerns about further asset bubbles remain strong.

...as well as the dangers of an “awareness gap” of the risk around us.

The second group of risks discussed in this report are also highly systemic in nature and require more global governance but they currently feature less highly in the assessment. The report raises these risks to understand if there is “awareness gap” around these areas and suggests that they should not be forgotten in the focus on an integrated and longer-term view of risks. These risks include: transnational crime and corruption; biodiversity loss; and cyber vulnerability

Risk highlights 2010

- *Underinvestment in infrastructure*

The 2009 Global Risk report noted the importance of spending decisions as governments launched fiscal stimulus packages to boost growth and create jobs. Infrastructure investment choices are key at any time, but they are particularly vital in four critical areas, agriculture, energy and transportation, and climate change adaptation, if the dual challenge of population growth and climate change is to be met.

The Global Risk survey data shows underinvestment in infrastructure as one of the most highly interconnected risks of the global risks set (see Figure 2). The strongest links are to fiscal crises, oil prices and natural catastrophes, but it also links to health issues, including infectious diseases as well as chronic disease and to food price volatility. The World Bank has put global infrastructure investment needs at USD 35 trillion over the next twenty years. In the US alone, the American Society of Civil Engineers rated US critical infrastructure as a “D” in 2009 and estimated that USD 2.2 trillion was necessary over the next five years. The US spends approximately 2.4% of GDP per annum on infrastructure, compared with nearly 15% of GDP on health. And as discussed below, these two areas are also linked.

- *Fiscal crises*

The credit crisis that affected financial markets triggered a broader and deeper crisis of confidence among business, investors and consumers alike. Individuals felt the downturn directly through falling property prices, tighter credit conditions and, most significantly, through job losses. Growth was driven by heavily indebted consumers, particularly in the United States. While in the short-term public spending can stimulate economies, over the longer-term corporate and consumer spending will be necessary to return to growth. Before this can happen, the process of deleveraging needs to run its course. Excessive levels of debt must be reduced, and consumption and investment needs to restart on a more solid footing. A fundamental shift must occur for this to happen. In fact two shifts, mirroring one another, will need to occur. Consumers in the West will have to adjust their spending, rely less on credit and save more, ideally saving more for their health and old age. In other parts of the world, and in particular in China, less saving and more spending to boost domestic demand will be key to future growth. At the heart of these shifts lie issues of behaviour change and confidence: confidence in the ability of the state to prevent further systemic risk from threatening the financial sector; to provide a level of social security to prevent individuals from falling into poverty and dependency; and a belief that the jobs are available coupled with a strong environmental awareness so that consumption becomes more sustainable.

- *Global governance gaps*

Global governance gaps remain high on the risk landscape but are the most significant source of risk in terms of interconnectedness; meaning that, independent from the experts' background, governance gaps was selected most of the time as a top connection and highly related to other risks. This shows experts have identified weak or inadequate institutions or agreements in almost all of the areas covered by our taxonomy. However, it also raises a red flag in terms of expectations regarding in which fields and concrete issues global governance bodies should take steps and get involved.

Global governance's relation with geopolitical risks has not changed from 2009. Interconnectedness with economic and environmental risks are the areas where there has been a marked increase in interdependencies. This suggests that the recession and the 2009 Copenhagen Climate Conference call for collaboration have had an impact on heightening awareness, developing insights and understanding risk interrelations, which has been translated in our survey in the form of more and stronger connections with this particular risk. It also reinforces the message of the 2009 Global Risks report on how crucial it is to focus on global governance not as an end in itself but as a means to address as many critical global risks over the coming years.

- *Chronic disease*

From the social domain in our taxonomy, "chronic disease" is another example of a slow moving shift. Its rapid spread throughout society worldwide (in both developed and developing nations), in an environment where societies are ageing fast, will have a significant impact on productivity levels and economic growth worldwide. The risk of not being prepared to confront a situation which requires massive spending on healthcare will undoubtedly add more pressure on public finances around the globe, planting the seeds of another systemic failure; and, in the short to mid term, the response of governments to such a threat would be much more constrained. This risk, however, covers a wider set of issues beyond the need of procuring medical attention to patients suffering from chronic diseases. Entire social safety nets are more at risk today, particularly social systems sustained with public subsidies.

3. Developing concepts for multistakeholder risk mitigation strategies.

Global financial services providers are keen consumers of the Report...

The Global Risk Report is targeted at a wide audience. Those with the greatest interest are those at the apex of the risk-taking pyramid; companies with a broad, diverse and interconnected risk portfolio. Reinsurers and insurers with global reach are prominent among those. Risk managers within other financial institutions take a similarly inclusive view of risk.

...as are companies with long supply chains.

Many companies outside of the financial sector have been surprised how the Global Risk Report affects their understanding of the risk challenges facing them. A number – such as oil companies or global food producers – have long and potentially exposed supply chains. Equally, manufacturers with a high reliance on commodities are especially aware of the exogenous shocks that could cause a sudden rise in prices.

For these companies, the Global Risk Report provides a framework in which they can take business decisions and sharpen awareness of systemic risks that may affect their businesses. For other companies, such as service providers, retailers, construction companies and others, the Global Risk Report provides insights into the secondary risks facing their businesses. Retail, for example, particularly for firms with longer credit lines, can be exposed to cash flow interruptions.

The Report is a dynamic process rather than static survey...

As the Global Risk Report is based on annual survey data, and updating its reporting structure is a continual process. Through the Global Risks Perception Survey the risk categories selected are subject to scrutiny and to change. Feedback is equally regularly received through scheduled meetings of the Global Agenda Councils. Lastly, the authors of the Global Risk Report work closely with partner organisations to understand how they view the global risk landscape.

Using this feedback, the Global Risk Report has seen its risk categories evolve over time. Food price volatility was a particular threat to many emerging economies in 2006–07. The threat of a hard Chinese economic landing became increasingly apparent as China began to emerge as a global economic power over the first decade of 2000.

..and is a continual platform for discussion for the WEF and its partners.

Moreover, the Global Risk Report is a catalytic document designed to engage and stimulate debate among those with responsibility for managing risk. It should – and has – facilitated collaboration and interaction between private and public sectors. Global Agenda Councils are one area of interaction for systemically significant players. Another is the major annual World Economic Forum meeting in Davos in January.

The Global Risk Report will doubtless continue to grow and be refined. It remains the one publicly available document that seeks to take a top-down helicopter view of global risk from a variety of standpoints, be they economic, geopolitical, societal, environmental or technological. That may make it seem distant for day-to-day business or government decision makers. This is precisely the point of the Global Risk Report – to remind its readers that we live in an interconnected and interdependent world. We are all part of wider systems. Apparently distant events or occurrences can go on to have often unexpected repercussions elsewhere. Simply managing the risk of an entity without taking into account these wider systems is no longer an option for managers.

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Chapter 2: Preemptive risk management strategies



As the human population grows, so do pressures on land use and the risks to which that land is exposed.



Advance recovery and the development of resilient organisations and societies

Herman B. “Dutch” Leonard, Arnold M. Howitt¹ – Societies face a wide array of significant hazards – ranging from the possibility of natural disasters to industrial accidents to large-scale terrorist incidents. These hazards vary in scale and in frequency, and by their nature we are generally uncertain not only about exactly when and where they might occur, but also about how likely they are to arise. The resilience of societies to natural and human catastrophes is the outcome generated by developing an effective overall strategy for social risk management. This will include both efforts at prevention and mitigation (which increases resilience by reducing the damage from which society has to recover), preparation of response capability (which increases resilience by improving the response when disaster strikes, thus reducing the bad effects of the emergency) and recovery (which embodies resilience by helping society to come back to a functioning equilibrium state from which it can continue its development and social progress). In the discussion that follows, we outline a framework within which we can develop and view a societal strategy to increase resilience and we point out an important component of such strategies – which we call “advance recovery”. Because advance recovery has generally received little attention, we believe there are significant unexplored, underdeveloped and unexploited opportunities in that domain for building more effective and complete strategies for social resilience.

Developing a comprehensive framework for examining social risks

Disaster relief tends to be focused on the immediate aftermath of the event...

A conspicuous focus of attention in how societies tend to deal with large-scale hazards is the direct response in the immediate aftermath of a breaking event.² The salience of emergencies once in progress – the needs of injured people and of people in peril – compels our focus and consideration. Repeated emergency events, and the obvious need for capabilities to respond as they unfold, leads to a parallel focus on organising and preparing response capabilities. Thus, the centrepiece of thinking about emergencies – the usual domain of “emergency management” or “crisis management” – tends to be the preparation and execution of response capabilities and actions that focus on emergency events themselves – on their short-run evolution and more-or-less immediate aftermath.

...however, disasters can have a long-term effect on social welfare...

From the perspective of overall risk management, however, this focus covers only a small portion of what societies can do to take account of – that is, to manage – the hazards that confront them. We take it as axiomatic that society’s goal in facing landscape-scale hazards should be to minimise the total expected loss of social welfare from such events (taking into account any resources used to manage them).³

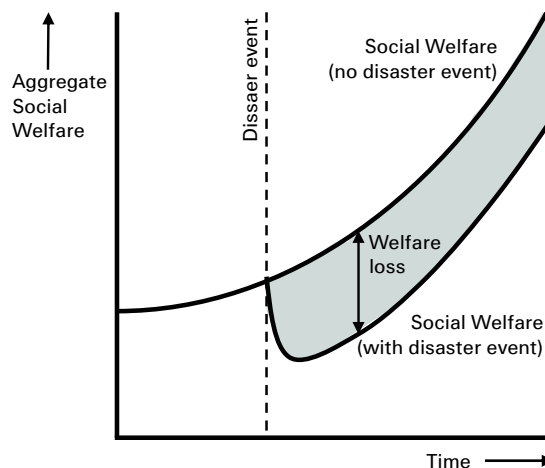
¹ We are indebted to Doug Ahlers, Arrietta Chakos, and David Giles for research support, comments, and suggestions. This research was generously supported by Swiss Re. Any remaining errors, alas, were always and still are our own.

² The argument in this section follows the reasoning in Herman B. Leonard and Arnold M. Howitt, Chapter 2 in Howard Kunreuther and Michael Useem (eds), *Learning from Catastrophes: Strategies for Reaction and Response* (Pennsylvania: Wharton School Publishing, 2010).

³ More precisely, we presume that society’s objective is to minimise the net present value of the probabilistically expected social losses associated with hazards, taking into account all resources associated with them. By referring to “present value”, we take account of the “discounting” of events that take place farther off in the future; because we can make investments with positive returns between now and the future, the value of resources consumed in the future (or of losses experienced in the future) is less than if the same consumption or loss were to take place today.

The losses are associated with the damage from the event, which reduces overall social welfare, and from the fact that social welfare does not recover immediately after the event.⁴ Figure 1 illustrates these losses, showing the (hopefully, generally rising) trajectory across time of overall social welfare before a disaster event and the trajectory of social welfare that would have obtained if the event had not taken place. Because of the event, social welfare falls as people are injured or killed and as valuable social assets are damaged. Eventually, as the destruction ends and recovery begins, the trajectory begins to rise again. In the notional example given in Figure 1, social welfare rises back towards what it would have been in the absence of the event, but does not again achieve the level that it would have had if the event had never taken place. There are, of course, other possibilities – a full recovery from a disaster event may be possible, bringing social welfare back to the level that it would have had without the event. Indeed, it is possible that welfare may eventually exceed what would have been possible in the absence of the event – as, for example, when socially obsolete assets are destroyed by an event, and society is able to replace them with assets better suited to current lifestyles.⁵

Figure 1:
Time path of social welfare
with and without a disaster
event



Source: Herman B. Leonard and Arnold M. Howitt, Chapter 2 in Howard Kunreuther and Michael Useem (eds) *Learning from Catastrophes: Strategies for Reaction and Response* (Wharton School Publishing, 2010).

...as can be graphically
demonstrated.

The total loss associated with the event, viewed in social welfare terms, is the area between the trajectory that welfare would have followed if not for the event and the trajectory that it actually follows once the event takes place. It is this area (plus any costs of avoidance, response or recovery) – the total accumulated losses over time plus costs of risk management – that society should be seeking to minimise.⁶

⁴ By “social welfare”, we mean the general well-being of the society, taking into account its economic product, the consumption that this allows its citizens, its political liberties, and its social “capital” or connections and relationships.

⁵ An example might be the ability to redesign a transportation system that had been heavily damaged, or to develop bike paths and a more environmentally friendly city in the aftermath of a major disaster. It might not have made sense before the disaster to demolish the old assets, but once the event has demolished them we may have a degree of design freedom that will allow a better optimised collection of social capital facilities.

⁶ Technically, the criterion society is trying to optimise, viewed probabilistically from a perspective before the event, is the expected present value (discounted for time) of the total social loss (given by the difference over time between the two trajectories in Figure 1) plus any costs spent on avoiding, responding to and recovering from the event.

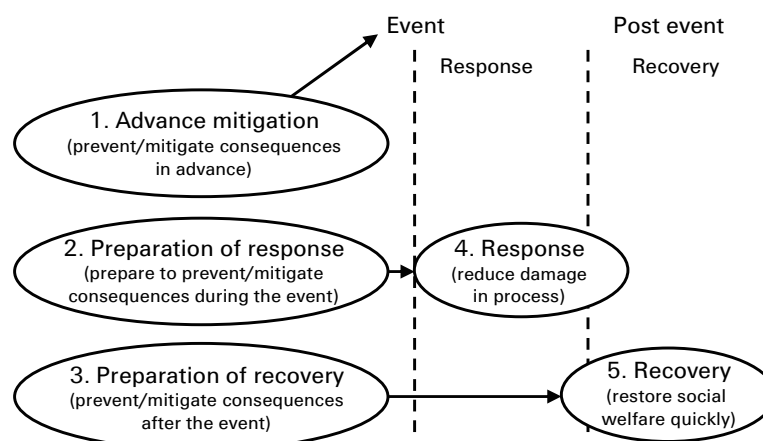
Societies can invest to
reduce risk vulnerability...

How can society reduce the (probabilistic) social cost of such risks? Logically, an emergency event taking place at a given time divides history into three segments – the time leading up to the event, the time of the event (while it is actively evolving), and the time following the event. Societies can and do take action associated with managing large-scale risks in all of these time frames. Emergency management focuses on two activities, in two of these time periods: the preparation for response during the pre-event time period, and conducting the response itself during the period of the active emergency. However, societies can also make investments seeking to change the nature of the hazardous events, either by preventing them altogether, by reducing their frequency, or by working to change their consequences if they do take place (for example, by making valuable assets more robust and harder to damage or by moving people and assets out of harm's way).⁷ The largest expenditures associated with large-scale hazards, however, are often those spent on recovery; once the response is carried out, there may still be (potentially large) amounts of damage that must be taken care of, and doing so will involve correspondingly large amounts of resources. This, in turn, implies that there is a fifth possible form of expenditure of resources to reduce overall social loss: activities can be undertaken that will prepare in advance for a recovery, making the recovery swifter, more efficient, more reliable and less expensive.

...which can be organised
through the use of an overarching
risk management framework.

Figure 2 shows these five different opportunities for investments that can contribute to reducing the overall cost of social hazards. We call this framework the “Comprehensive Risk Management Framework” (CRMF) because, collectively, these five areas of investment include all of the possible forms of action that societies can take to manage social risks.⁸ The framework thus provides a way of thinking about the level and composition of investments and activities across these different points of intervention – so that we can consider whether the investments we are making constitute the best possible portfolio of actions that society can take in the face of the risks it confronts.

Figure 2:
The Comprehensive Risk
Management Framework



Source: Herman B. Leonard and Arnold M. Howitt, Chapter 2 in Howard Kunreuther and Michael Useem (eds) *Learning from Catastrophes: Strategies for Reaction and Response* (Wharton School Publishing, 2010).

⁷ For example, the World Bank's Global Facility for Disaster Reduction and Recovery is reassessing its development policies to better address disaster resilience and to realign assets towards pre-event risk reduction.

⁸ For a more detailed description of the Comprehensive Risk Management Framework, see Herman B. Leonard and Arnold M. Howitt, *op cit.*

Risk-reducing investments are
often distributed sub optimally...

In general, do societies make the right level – and have the right composition – of investments in avoiding social loss from risk? We believe that the distribution of effort across different opportunities to manage social hazards is conspicuously different from what would be optimal. Societies generally concentrate on some and under-invest in others. In the midst of a major event, there tends to be an often-appropriate instinct to provide “all available” resources to aid the injured and the imperilled – so spending on response tends often to be formidable. In addition, once the event has stopped unfolding, there is usually little choice but to spend the (very large) amounts of resources that may be necessary to at least partially rebuild and recover. Once the event is taking or has taken place, it is no longer probabilistic, off in the future, and avoidable; it is here now and it demands resources and attention. By contrast, spending in the first three categories shown in Figure 1 must take place in advance of the event, when it is only a possibility and is potentially far off in the future (so that we may assume that we will still have time to mitigate or prepare later even if we attend to other priorities first). Given human (and institutional) myopia and proclivities to not always think rationally or effectively about low probability events or about events that are potentially far off in time, it seems likely that too little effort is made in this area in general.⁹ This may be all the more so because people dislike thinking about events that may have horrible consequences, preferring to contemplate and plan for such circumstances tomorrow.¹⁰ This suggests that the overall level of spending on the three areas of pre-event investment may be comparatively too low and the spending on response and recovery comparatively too high. Among the three pre-event areas of spending, however, the most salient is generally the preparation of response – in the aftermath of an event, we never seem to have been able to respond quite fast enough, and thus we tend to emphasise spending on building response capacity – so the areas that are likely to be most underrepresented in our thinking and action in advance are the areas of prevention and mitigation, on the one hand, and preparation for recovery, on the other.

...despite relatively low opportunity
costs...

Where, then, are the greatest opportunities for improving the composition of and balance among our expenditures in the five investment areas identified by the CRMF? In our view, prevention and mitigation of large-scale social hazards probably does not get enough attention within the portfolio of investments. Societies frequently regret, in the aftermath of major events, that they did not undertake better prevention and mitigation in advance.¹¹ The levee failures that drowned New Orleans in the aftermath of Hurricane Katrina are a prime example where relatively small amounts of additional spending in advance could have produced dramatic savings in the face of the storm. Storms of this magnitude occur regularly, and engineering studies clearly indicated that the levees might fail in the face of a Category III hurricane. That is not a rare event in New Orleans, occurring about once per generation. (Indeed, Katrina was actually only a Category II storm by the time it came ashore in Louisiana, so society had purchased even less protection than it thought.)

⁹ A Pew Research Center for the People and the Press poll released on October 22, 2009 (reported on National Public Radio the following day) showed that 57% of American surveyed in October 2009 thought there is “solid evidence that the earth is warming,” down 14 percentage points from an April 2008 poll and apparently indicating a significant reduction in concerns about the environment. (Poll results accessed at: <http://people-press.org/report/556/global-warming>, November 2, 2009.)

¹⁰ New York Times’ writer Nicholas Kristof writes about typical human avoidance to consider imminent hazards in his column “When Our Brains Short-Circuit”, *The New York Times*, July 2, 2009.

¹¹ For evidence of the efficacy of predisaster mitigation efforts, see: Multihazard Mitigation Council, *Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities* (National Institute of Building Sciences, 2005).

Thus, it seems clear that we do not have the optimal portfolio of overall investments, and that we are under investing in prevention and mitigation. Nonetheless, these areas do at least get some attention, and there are significant examples of effective mitigation – the dykes in the Netherlands, for example, and the cyclone shelters in Bangladesh are frequently-noted examples of successful efforts to cope with hazards by shaping their consequences through action in advance.

...and with insufficient regard to advance recovery.

By contrast, we note that the area of advance recovery – thinking carefully in advance about how to accelerate recovery after the fact – is virtually undiscussed and unpopulated by examples of effective strategies for action. As a result, in this discussion, we will focus on the management of recovery – particularly in the form of “advance recovery”.

Recovery and advance recovery as parts of the comprehensive risk strategy for social risks

Measures to encourage post-event recovery can be enacted pre-event...

Far and away, the largest expenditures associated with addressing large-scale social risks occur in the aftermath of events that were not successfully prevented or mitigated in advance. As Figure 1 illustrates, social losses occur in two forms: first, in the damage and destruction of the event itself (which, in the case of large events, significantly reduce social welfare as the event unfolds); and, second, through the often quite long-term accumulation of losses in the form of social welfare remaining below the value it would otherwise have had until recovery is successful and complete. The longer recovery takes, the more these losses accumulate. Thus, actions that we can take during recovery or before the event that will accelerate the recovery process, make it more reliable or make it less expensive may have very large net social returns. If we could find actions in advance of the event that were relatively inexpensive but that could help to accelerate recovery in a variety of after-event circumstances, these might be particularly high-value investments. In effect, advance recovery activities amount to prevention or mitigation of recovery spending that might otherwise take place. Rather than shaping the event or the response to the event, the intention of these activities is to shape the recovery that will take place after the event.

...and should be distinguished from immediate disaster relief.

Historically, recovery has been thought of as a set of activities that begin as the response phase of a disaster event comes to an end.¹² To the extent to which there is active consideration of how to make recovery faster or easier or less expensive, it is generally through the approach of reducing the damage (either by preventing the event in the first place or through attempting to protect valuable assets by hardening them to prospective damage). Nearly universally, it is assumed that recovery cannot be planned, nor significantly prepared for, in advance. Recovery is treated as something that simply has to be invented after the fact.¹³

¹² For an exploration of traditional approaches to planning for and managing recovery, see: Brenda D. Phillips and David M. Neal, “Recovery”, in William L. Waugh and Kathleen Tierney (eds.), *Emergency Management: Principles and Practice for Local Government, 2nd Edition* (Washington DC: ICMA Press, 2007).

¹³ One exception to this almost-universal practice is a set of recently released disaster recovery plans from jurisdictions on the east coast of Florida in the US. State law now requires such plans from every coastal community, though few cities are yet in full compliance with this mandate.

Unique events negate having specific planning measures...

The reasons for this are not difficult to see. Every disaster event – and especially every large-scale event – is indeed unique. Large events are highly complex, and generally highly variable. The specifics of damage and injuries, the details of human needs, the requirements for reassembling a functioning economy and social ecology – all of these are difficult to plan for in any detail across the physical terrain in which a disaster might strike. Even after the event, it is difficult to discern what has happened and determine the kinds, location and sequence of needed recovery activities, as can readily be seen by looking at the aftermath of historical events. Thus, relatively little *specific* planning or preparation for recovery, done in advance of the event, is likely to prove very useful.

...but general planning measures can still be effective.

More general planning and preparation, however, could prove very useful in accelerating recovery – and is therefore both much more valuable and easier to carry out. In spite of this fact, most countries have no systematic method for identifying and investing in advance planning to make recovery from hazardous events more rapid, more reliable and less expensive. To see what kinds of general preparation might be useful, it is instructive to examine the (still ongoing) recovery of New Orleans in the aftermath of Hurricane Katrina, and it is to this that we now turn.

Hurricane Katrina and the (highly variable) recovery in New Orleans

Too much stress is placed on external and centrally planned assistance...

In most large-scale post-disaster situations, there is a widespread presumption that external (and, generally, centrally-driven) assistance will be needed. There is also often a general belief that the process of recovering does not depend very much on the source of the damage. If schools and housing have been destroyed, they need to be rebuilt whether they were destroyed by a flood or by an earthquake. In this sense, recovery often seems to be viewed as a form of general economic, social and neighbourhood development.

Centralised action in recovery often focuses initially on community planning, and this was a major feature of the activities conducted by government in New Orleans after Katrina. Wave after wave of planning efforts were undertaken with relatively few effects. (The fact that there were multiple central planning efforts is itself testimony to the fact that they were generally of little use.)

...whereas community action is often more effective, as shown in certain New Orleans neighbourhoods.

New Orleans provides an instructive example for recovery (and advance recovery), precisely because the pace of recovery in different neighbourhoods has been highly variable. Some heavily damaged communities have recovered much faster than others, in spite of having similar pre-storm socioeconomic circumstances and similar levels of damage in the storm. Our project team has worked extensively with and documented the progress of one community in particular, known as the Broadmoor neighbourhood.¹⁴ After an initial period in which neighbourhood residents waited hopefully for external assistance, neighbourhood leaders emerged and helped the community self-organise.

¹⁴ See Esther Scott, “Broadmoor Lives”: A New Orleans Neighborhood’s Battle to Recover from Hurricane Katrina (A, B, and Epilogue), John F. Kennedy School of Government, Harvard University (2008) for a detailed examination of the Broadmoor recovery experience; a good discussion of post-Katrina recovery can also be found in Craig E. Colten, Robert W. Kates, and Shirley B. Laska, “Three Years after Katrina: Lessons for Community Resilience”, *Environment*, 50(5) (2007): 36–47.

Over the ensuing four years, the Broadmoor Improvement Association – importantly, a pre-existing organisation with leaders who had begun work before the storm on neighbourhood issues (crime, housing abandonment, and so on) – first organised a repopulation effort to locate former residents and encourage them to return; then organised efforts to help residents secure access to housing reconstruction and other assistance programmes; then organised the development of a charter school and the rebuilding of the local elementary school; and, finally, led the community in the development of a new library and community centre that is part of a technology corridor that promises to transform the public space in the community.¹⁵ Meanwhile, some other communities in New Orleans – in no worse physical condition before the storm, and with a similar socio-demographic mix before the event, and no more heavily damaged by the storm – have recovered much less extensively and much more slowly.

What seems to have made the difference in communities like Broadmoor that have been able to mobilise relatively rapid recoveries?

Our research suggests that five factors were particularly important:

1. Successful communities were highly self-reliant – they did not wait (or did not wait long) for external “others” to come and help them organise, develop plans and get projects underway. Instead, they developed strategies and processes to identify and deal with the sequence of challenges confronting them – and got started working on them.
2. Local leaders emerged who had some prior experience in working on neighbourhood issues (and, thus, credibility with residents).
3. Successful efforts more often resembled community organising (understood as the internally-driven mobilisation of community residents to engage a sequence of community challenges) than community planning (understood as an outside-expert-led process of “consultation” with neighbourhood residents). When planning was carried out as an external process, it generally failed; when it was organised by the community, it generally succeeded.
4. Local leaders and organisations were highly adaptive – they were able to master, in sequence, a series of very different challenges (starting with repopulation, moving on to dealing with government bureaucracies to get utilities reconnected, developing capacities to help residents access government aid programs, and moving on to organising planning, development and longer term community improvement efforts).
5. Local leaders proved able to identify and establish effective working relationships with outside agencies (in the governmental, non-profit, foundation and corporate sectors), through which they were able to mobilise resources that included training and advice and assistance in planning and organising, in addition to funding.

These observations from New Orleans frame an important lesson about recovery: all disasters are ultimately local (that is, large disasters are actually best viewed as a collection of smaller community disasters) – and, therefore, all recoveries are ultimately local. What implications does this have for recovery in general – and advance recovery in particular?

¹⁵ The Broadmoor community provides an excellent example of a phenomenon of resilience examined by Rebecca Solnit. Solnit explores the transformative qualities of disasters in her works, “The Uses of Disaster” *Harper’s Magazine*, September, 2005 and in the recently published, *A Paradise Built in Hell: The Extraordinary Communities That Arise in Disaster* (New York: Viking Publishing, 2009). The “Solnit Effect” as it might be called refers to the naturally-occurring resilience that social groups often demonstrate in the aftermath of disaster.

Advance recovery: some key elements for accelerating recovery

In post-disaster areas,
displaced persons must be
enticed back...

Large-scale disasters result in the displacement of significant numbers of people, so a first-order challenge in recovery is bringing displaced persons back. More specifically, this means securing the interest of community residents in undertaking the enormous amount of personal and community effort necessary to rebuild and recover. Former residents generally have a high degree of attachment to their homes and communities; but in the aftermath of an event that has visibly destroyed their former lives, many will ponder whether (or, at least, how soon) to return and reinvest. Many will have location alternatives. Indeed, those whom the community might be the most interested in retaining will often be the ones with the best alternatives. Moreover, the likelihood that people will decide to return and reinvest is likely to depend in significant measure on what they think others will do. Will their neighbours clean up and help bring the community back? Or will they find themselves the only committed family on their block, now surrounded by dark and damaged structures?

...a process which requires
sufficient momentum
to reach a "tipping point".

Thus, there is a "tipping" phenomenon that will begin in the immediate aftermath of a major disruption, and it will continue for some time. If people believe that most others are likely to return, they will be more likely to return; if they believe many will hesitate, they are also likely to hesitate. Obviously, such prophecies are self-fulfilling, and they are largely based in subjective estimates about the future behaviour of others. Since tipping will begin soon after the event stops unfolding, little objective data will be available about the rate of recovery. The community as a whole, therefore, has a very large interest in influencing how residents assess whether to return interpret the likelihood that they will be joined by many others. Creating the (self-fulfilling) perception that the recovery will be rapid and robust is an important element of mobilising a rapid recovery process. Devices that allow early demonstration of community leadership competence and the availability of resources to enable and enhance recovery can thus potentially have a powerful impact on the rate of recovery. They will influence the degree to which former residents mobilise their own resources and efforts. An important part of rapid recovery, therefore, will be taking actions to encourage former residents to "tip in" to the recovery effort.

What can be done in advance to influence the tipping process positively and, more generally, to mobilise a swift and effective recovery?

Several elements appear important:

1. **High-quality community-based leadership:** If people are going to be encouraged to tip in, they will need to see and believe in their local leadership – and they will need to see early demonstrations of its engagement and competence. Efforts to build community leadership – valuable in its own right for dealing with ongoing challenges – are thus an important asset for advance recovery.
2. **Demonstrated government capabilities and resources:** Government activities will be a key component of any major recovery, so clear indications, early in the recovery period, that government is effective – and has access to the resources that it will need – is a key asset in building confidence in the pace of recovery.

3. **Pre-existing relationships with outside organisations:** During recovery, the ability to connect to and mobilise resources of various kinds – technical expertise, advice, assistance in planning, funding, and so on – from outside agencies is a key determinant of the rate of progress. Such relationships are important, among other reasons, because they allow the community to draw on resources from outside the impact zone that were not damaged or consumed by the disaster. Building these relationships in advance and maintaining them in early recovery is highly important. Early demonstrations of the existence and effectiveness of these relationships can enhance confidence that recovery will be swift and sure.
4. **Ready availability of discretionary funds:** Whatever else recovery from a major disaster may require, it will require prodigious amounts of resources. The demonstration that funds are available, liquid, and under local discretion can significantly enhance confidence that recovery activities will begin rapidly and will reflect local community interests and values. Particularly important are devices that provide funds quickly and without major restrictions or entanglements with agencies not familiar with and responsive to the community that is trying to rebuild.
5. **Availability of credit:** Closely related to the availability of funds is the availability of credit. After a major event, individuals and jurisdictions in the impact zone will suddenly find that they have become conspicuously less creditworthy than they were before the event. If they seek to borrow money after the event, they will find it at best difficult and often impossible. Thus, devices that would provide credit after an event must be arranged before an event. In effect, such devices would amount to the purchase of a credit guarantee – assurance that individuals and institutions would be allowed to borrow even in the aftermath of a major disaster.

These advance recovery elements do not by themselves guarantee a rapid recovery, and there will be many other elements that may prove relevant to recovery from specific kinds of disasters or in a particular community. These elements, however, can be viewed as components of a “platform for accelerated recovery” – a set of conditions and actions put in place in advance that will help communities mobilise swifter, more effective and more reliable recovery efforts.

An example: advance recovery from the next San Francisco earthquake

San Francisco is highly
vulnerable to earthquakes...

The San Francisco Bay Area (like parts of Southern California) notoriously faces with high likelihood a major seismic event in the next 20 to 50 years. The continuously shifting tectonic plates along the fault lines that run under the Bay Area create a flow of energy into the fault system; episodically, it must break. Exactly when this will occur is not predictable with current science and technology. What is known is that major events must occur on occasion to relieve accumulating stress in the system; recurrent small events do not release enough energy to allow the system to stay in equilibrium. The Hayward fault, for example, which runs under the city of Oakland, across the Bay Bridge from San Francisco, has (according to current interpretations of the historical geologic record) experienced major events on average every 140 years – and last experienced a major event 142 years ago.

...prompting substantial risk mitigation measures from local authorities...

Awareness of these hazards has prompted considerable work in the Bay Area, principally in the form of preparation for response to a seismic event (area 2 in Figure 2) and in the form of mitigation measures (area 1 in Figure 2), such as retrofitting public facilities like hospitals and government offices, establishing building codes for seismic protection, and removing or retrofitting “unreinforced masonry buildings” (which are subject to collapse in the event of earthquakes). Significant preparation has also been made to ensure that utilities (gas, electric and water systems) disrupted by an event can be quickly restored.¹⁶ In general, Bay Area regional investment in pre-disaster risk reduction is considerably above the norm for comparable metropolitan areas. Particularly since the 1989 Loma Prieta earthquake struck the area, local, state and federal initiatives have funded substantial hazard mitigation in infrastructure systems and the built environment.

...including a shift in priorities to take account of advance recovery.

Though the Bay Area has generally been quite active in noting seismic hazards and making at least some preparatory investments to reduce the risks, it has not fully addressed the larger agenda of trying to improve the rate, reliability and effectiveness of recovery. Recognising, in effect, that it had an unbalanced portfolio of investments across the areas of preparation noted in Figure 2 – and, therefore, faced the prospect of greater damage and a longer- and more expensive-than-necessary recovery, the City and County of San Francisco have recently undertaken an ambitious program directed at identifying and activating key opportunities for advance recovery.¹⁷ Organised by the City Administrator’s office (which oversees the day to day functions of the government), this effort has engaged government agencies ranging from the Comptroller’s Office (in charge of finances and borrowing for the city and county) to the Department of Emergency Management (which handles response planning and which would direct the response to the event). Teams within these agencies are working to identify key issues that might arise in the aftermath of a major event and are thinking through the existing legal, policy and financial constraints to see where changes might be made now in order to significantly improve the rate of recovery after an event.

By way of illustration, the projects currently underway include:

- a) **Efforts to develop templates for a post-event budget:** In the aftermath of an event, the municipal budget will necessarily be considerably reshaped, as both priorities and available funding shift. Contemplating in advance what that might look like – and building budget templates that would frame the questions and issues for those trying to develop a recovery strategy – could considerably reduce the time needed to articulate new priorities and develop a meaningful and realistic plan for recovery.

¹⁶ To the extent that restoration of utilities is viewed as part of recovery, these preparations for quick reconnection constitute a form of advance recovery; if restoration is viewed as a part of the response to the disaster, then these preparations qualify as part of preparation for response. Regardless of how we choose to classify them, they are potentially important investments, and they have been successfully identified as opportunities and actually carried out.

¹⁷ Our programme has been closely involved in San Francisco’s advance recovery planning efforts through the Harvard Kennedy School’s Acting in Time Disaster Recovery Action Research Project, a component of the multidisciplinary *Acting in Time* research initiative developed by Kennedy School Dean David Ellwood. This initiative seeks to address a set of major public issues by exploring both the challenges of and possible paths forward for mobilising action and effecting policy in a timely manner. For more on *Acting in Time* see <http://www.hks.harvard.edu/about/admin/offices/dean/acting-in-time>.

- b) **Contemplating a post-event recovery period organisational structure:** Because the demands of recovery will be front and centre once an event takes place, the existing organisational structure – the pre-event, “peacetime” structure, as it were – may not be suited to orchestrating the most rapid possible recovery. Clarifying post-event lines of authority, priority and precedence among municipal agencies could take a considerable amount of time in the post-event period. Thinking through some of these issues in advance – and putting in place a new organisational template (and, possibly, the legislative authorisation to reorganise along the new lines in the aftermath of a major event) could significantly increase the city and county’s ability to move to an effective “wartime” recovery footing.
- c) **Negotiating emergency recovery period “work rule” variances that could be activated after an event:** In ordinary times, city employees operate under collective bargaining and/or civil service work rules that constrain the extent to which they can be reassigned to other duties. In the aftermath of a major event, when city and county priorities would have to shift markedly to confront the new challenges, the existing rules could prevent the effective employee deployment to the locations and purposes for which they are most needed to enhance recovery. Negotiating in advance the authority to suspend some rules or even creating a whole new set of rules that would apply in a post-event recovery period might significantly improve the ability of government agencies to adjust manpower resources to meet sudden new demands.
- d) **Providing emergency purchasing and financial powers:** When the city and county are confronting a wide array of sudden new demands, the existing “peacetime” structure of purchasing and financial transfer rules, regulations about credit relationships, and borrowing procedures may be significant obstacles to moving quickly to mobilise recovery actions. Creating a suite of emergency powers for purchasing and for financial transactions could remove some of these obstacles and enhance the likelihood of a swifter mobilisation for recovery.
- e) **Creating “earthquake proof” credit instruments:** The financial capacity of Bay Area governments to carry debt burdens will be significantly altered by a major seismic event. They will face increased demands but significantly reduced revenues from taxes on economic activity and from property taxes assessed on now-damaged buildings. Property values will have fallen as a result of damage, and building owners (especially businesses) may suffer economic losses that make it impossible for them to meet their tax obligations.¹⁸ Government debt-carrying capacity, as assessed by rating agencies and bond buyers, is likely to be considerably reduced as compared with pre-event levels. If Bay Area governments try to borrow after the event to meet sudden new investment demands, they are likely to find that they have poor (or no) credit. Consequently, as a part of an advance recovery strategy, San Francisco is trying to devise innovative credit devices. These instruments would be executed in advance with a view to establish credit facilities that would guarantee the city’s capacity to borrow up to pre-designated amounts in the aftermath of an event. Several forms are being examined, ranging from cross-guarantees of credit by other city and county governments (not all of which would be likely to be affected by the same event, even if it were large-scale), to private sector agreements in tax exempt bond markets to establish an “earthquake proof” line of credit on which Bay Area governments could draw in the aftermath of a major event.

¹⁸ The prospect of the Bay Area governments foreclosing on damaged buildings for non-payment of taxes is hardly one that would enhance confidence in the pace of recovery.

Mutual insurance arrangements can probably be executed without current budgetary impact (and probably should be). By contrast, purchasing guarantees of access to a credit facility would require some form of annual payment; since this is a form of insurance, there would be a premium associated with it.

f) Creating pools of available assets that can be drawn on in case of an event:

Cities generally have reserves that give them the capacity to adapt to small fluctuations in economic activity (and their associated revenue flows) or to variations in the rate at which expenditures are made. However, these reserves are typically limited to a fraction of one year's expenditures. By contrast, extraordinary demands for spending during disaster recovery could involve multiples of the entire annual budget. Of course, some of these expenditures might eventually be reimbursed through national or state aid programmes for the disaster-struck region – but it would nonetheless seem wise, as a matter of advance recovery, to demonstrate financial stability by arranging for significant pools of funds that would become available in an emergency. One form of this that the City and County of San Francisco are contemplating is the development of an endowment fund – financed either through diversion of current revenues or through the issuance of taxable bonds. The funds in the endowment would be invested, so that the endowment would grow over time, and the funds in the endowment would be available for use in a major emergency. A particularly powerful form of such an endowment would be to construct it on a mutual basis, with other cities and counties (some, hopefully, from areas outside the likely impact zone for a Bay Area event) contributing funds and allowing those funds potentially to be drawn against by a member of the mutual endowment that experienced a pre-defined devastating event.¹⁹

These examples, currently being contemplated, designed, and/or undertaken by the City and County of San Francisco, illustrate the kind of actions that may be taken in an advance recovery programme. Yet, they are not comprehensive, only suggestive. The project in the City and County of San Francisco has been ongoing for about 18 months, and while there is still much opportunity for inventing new strategies, significant progress has already been made in identifying ways in which current plans and rules (or the lack thereof) would significantly impede rapid recovery – and in developing ways to change those arrangements (or form new ones) to make recovery less expensive, more reliable and shorter.²⁰

¹⁹ The event(s) could be defined in advance (“a seismic event of magnitude 7.5 or greater with an epicenter within 20 miles; or 8.0 or greater with an epicenter within 60 miles”), or could be defined by a particular form of disaster declaration (“if both the mayor and the governor designate the emergency as a major disaster”).

²⁰ Other work is also contributing to this effort. In “The Resilient City, Part 1 – Before the Disaster”, commentators posit the recovery capacities a post-disaster San Francisco ought to have in place before extreme events strike. This progressive thinking is helping to shape local planning (in “The Urbanist”, published by the San Francisco SPUR institute in February 2009).

Innovation in insurance markets to improve advance recovery

Traditional insurance post-disaster is limited by contract conditions...

Traditional insurance plays a major positive role in accelerating recovery by covering damage to insured assets and providing resources for repair and reconstruction. Generally speaking, insurance was limited historically in the types of damage it insures against (for example, excluding acts of war, or covering damage from wind and rain but not from flooding), and thus is not available to aid recovery from some kinds of events. For example, in the wake of Hurricane Katrina many households in New Orleans found that the insurance they had relied on did not cover the damage that they had actually incurred. They were left to seek other post-event aid programs or forced to rely on their own resources for rebuilding. This has significantly slowed the pace of recovery for some households and communities.

...however, catastrophe bonds can have clear triggers...

More recently, new forms of insurance-like instruments in the form of catastrophe bonds have begun to shift this landscape. Commonly issued by insurance companies as a means of reinsurance, catastrophe bonds are standard bond issues in which the principal is forgiven if a defined event takes place. The event can be described either (1) as a specific loss (by a particular company), (2) as an aggregate loss (by an industry from an event), or (3) can be parameterised by the scale of an event (wind speed at designated sensors, magnitude of an earthquake with an epicentre within a specified distance of a given location, and so on).

...providing quick liquidity which can be spent in a discretionary manner.

Bonds of this form have most commonly been issued by (re)insurance companies that have underwritten risks in a given location and that seek investors willing to take on those risks on their behalf, but they can just as easily be issued by jurisdictions in contemplation of the need for liquid funds in the aftermath of an event. In the case of a jurisdiction, it may make sense to issue bonds parameterised by the scale of an event – since this will prevent any delay that might arise from the need to assess the level of damage actually incurred. For example, Mexico recently issued catastrophe bonds that will provide resources in the event of severe earthquake or hurricane damage. Catastrophe bonds might provide one possible avenue for funding the endowment fund described above as a device for demonstrating financial stability and providing liquid funds after a disaster event.

Other innovative forms of insurance could also aid in the construction of advance recovery strategies. For example, as described above, jurisdictions may need to seek guarantees that they will be able to borrow after a major event; developing insurance instruments to guarantee credit availability would be a useful innovation that would facilitate the spread of this component of advance recovery.

Conclusion

Developing an effective advance recovery strategy to reduce the expected long-term costs of recovery will depend on the specific circumstances – both on the hazards faced and on the existing plans and institutional structures – of potentially affected jurisdictions, and will require analysis and ingenuity. An advance recovery strategy in a seismic hazard zone like the San Francisco Bay Area will be very different than in a cyclone-prone area like the Gulf Coast of the US, the Philippines, Bangladesh or Taiwan. Moreover, those areas that are subject to similar hazards will still want to develop different strategies, because their existing systems and institutional structures will have prepared them differentially for recovery and will leave them with different unaddressed recovery challenges that can be mitigated by actions in advance of an event. Simply put, however, our central point is that because most jurisdictions have not focused on advance recovery as a separate area of attention and investment, there are potentially great opportunities for inspired thought and action in this domain. Jurisdictions may achieve very high ratios of returned value by increasing the effectiveness, reducing the cost and shortening the duration of recovery from the next major event that will befall them.

Social resilience in the face of disaster is not, itself, an activity – it is an outcome of effective social risk management activities. Developing the right level of resilience will flow from judicious choices about where society can make the best investments in overall social risk reduction. Effective strategies for resilience, therefore, can be guided by effective search within the domains of risk reduction activities outlined by the Comprehensive Risk Management Framework – and, as we have argued here, some of the best opportunities for enhancing resilience at relatively low cost lie in the area of developing effective advance recovery actions and strategies.

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Country risk management: Managing interrelated risks at country level

Jack Radisch – Country risk management follows from the duty of states to protect the people, assets and environment in their territories from the natural and man-made hazards they face. It is infinitely easier to state this simple proposition than it is to arrive at political consensus on what concrete actions should be undertaken to provide effective and efficient means to achieve the state's mandated ends. First, many natural and man-made risks traverse the artificial borders of states and jurisdictional limits of public administrations that are responsible for planning and responding to them. In a world where economic and technical integration continues to accelerate, the identification, analysis and mitigation of risks requires not only coordination of the whole of government, but also international cooperation in some instances. Second, governments should prioritise damage reduction efforts to the most likely scenarios for massive disruption, by ranking risks through sound analysis that is subject to a process of validation. Third, governments cannot provide zero risk to their citizens; they have to set priorities, accept trade-offs and manage the results, which requires partnerships with non-governmental stakeholders, from technical expertise on risk identification and analysis, to reinforcing disaster response and recovery capabilities.

Why governments must change how they manage risks

The general trend of disaster losses is upwards...

Significant shifts to the frequency, impact and very nature of risks in the 21st century have prompted governments to adjust their risk management strategies. An indicator of this shift is the stark increase in magnitude of disaster losses measured directly in property damage and indirectly as lost productivity. The economic impacts of disasters can be modelled approximately within an input-output framework. However, insurers and reinsurers can provide precise, quantifiable measures for a portion of total losses. In 2005, economic losses from natural catastrophes spiked, with direct financial losses of about USD 230 billion, representing 0.5% of total worldwide GDP, of which USD 83 billion was covered by insurance.¹ Unprecedented damage from Hurricane Katrina accounted for much of the losses that year, which led many people to hope 2005 was an historic anomaly. Economic losses from natural disasters in 2008, however, turned out to be the second highest year on record.

...while the vulnerability of societies has increased, both in terms of population concentrations...

Mass media has enabled the general public to follow worldwide increases in the frequency and magnitude of natural and man-made disasters over the past thirty years. What is less obvious to observe, much less control, are underlying changes in societies that have increased their vulnerabilities. Socio-economic trends such as rising population densities and value concentrations in geographic areas exposed to hazards play a significant role. Over the past sixty years increasing proportions of the labour force have come to work in industry and services, which has driven unprecedented urbanisation. Since 2008, for the first time, more than half the world's population lives in urban areas. Some parts of the United States that have enjoyed the highest rates of economic and population growth over the past 30 years are exposed to extreme natural risks: earthquakes and wildfires are a constant threat in California, while hurricanes have repeatedly wrecked havoc in Florida. Despite the fact that these risks are well publicised both states have enjoyed successive construction booms,

¹ Swiss Re, *sigma* No 2/2006.

which might indicate that people are willing to assume a level of risk to live in a warm and comfortable climate. Another explanation is that they blindly believe disasters only happen to other people. Migration of retirees to these warmer climates further promotes economic development and job creation, which draws even more people to live there.

...as well as technical proliferation and interconnectiveness.

Vulnerabilities have not only increased due to socio-economic factors, but also due to the technological and economic interconnectedness of communities across the world. Natural and technological disasters hold potential to disrupt or destroy vital services and infrastructure, and may impact economic activities far removed from the original event. This increases uncertainty regarding the beginning and end points of risks, as seemingly far away events may cascade into transnational shocks. Although the liberalisation of global markets and just-in-time supply chains improve living standards for many people, they may also extend the effects of disruptive events. Privatisation in key industries is another economic trend over the past 20 years that can create uncertainties regarding who is ultimately responsible for preventing or mitigating risks associated with their activities.

The increasingly integrated risk landscape...

The current financial crisis is an illustration of how even robust regulatory approaches may fail to foresee how risks to one sector of the economy can carry global ramifications. Nearly one year after the global credit crunch, many global regulations have been proposed to prevent such a crisis from happening again, but very few new concrete actions have actually been taken. Given the stakes involved such hesitancy to act serves to remind just how delicate and complex the global financial system is and reveals awareness amongst policymakers that government interventions could severely undermine its efficiencies and opportunities for rewards. There are many other vulnerable systems supporting modern living standards, such as communications, transport, energy and public health, each of which needs to be reliably secured without being overly encumbered.

...affecting every level of society and the governance of society.

The risk landscape of the 21st century is characterised, therefore, not only by the heightened vulnerability of societies, but also by uncertainty about what and where risks are, the extent of their impacts and, at times, doubts about whether they can be managed. There has been progress in many advanced economies in addressing exposure to natural and technological hazards. Policies reflecting the doctrines of sustainability are slowly taking hold in urban development, which should help reduce damages from some types of risks. Technological innovation and redundant systems in certain sectors reinforce the continuity of operations against shocks to any one of a multitude of essential links in their supply chain. In addition, governments are actively trying to fill knowledge gaps, and reorganise their services to create the synergies capable of identifying, responding to and recovering from large scale risks.

Integrated country risk management

Policy-makers must isolate key decision-making metrics.

To address the complexities of the above described risk landscape, governments do not simply set out to accumulate more information. The main challenge has been to process and synthesise the mountains of information and data on risks that they already possess, and continually aggregate such information into such a form policymakers can use to make informed decisions. Two developments in country risk management are of particular note in this regard: all-hazards policy frameworks and national risk assessments.²

² See: "Innovation in Country Risk Management" (OECD 2009).

A policy framework is required for post-disaster institutional coordination...

All-hazards policy frameworks

Modern country risk management requires a mechanism to integrate information from a diverse set of government bodies and private actors. Such coordination has historically been a weakness in country risk management systems, because it is usually built on ad hoc cooperation between various agencies at different levels of government under the difficult circumstances of a major disruptive event. In the immediate aftermath of disastrous events, these actors often recognise the value of coordinating to prepare accurate risk analysis and cooperation protocols before the next disaster strikes, but until recently there was seldom any policy framework for such coordination.

...which can be implemented through an “all-hazards” risk management policy...

For these reasons several countries have adopted formal “all-hazards” policy frameworks to obtain a portfolio view of the full range of risks they face by integrating the work of various public and private organisations into coherent and credible sources of information. All-hazards frameworks help integrate the risk analysis of public authorities from central, regional and local levels of government, and to varying degrees include private parties such as operators of infrastructure and insurers. This work entails coordination of multi-disciplinary expertise, information sharing arrangements that ensure confidentiality, improvement of data integration capacity, investment in training civil servants and cooperation exercises across multiple agencies involved in country risk management. There is no one-size-fits-all solution to the implementation of an all-hazards approach to managing a country’s risk portfolio, though direct support from the head of government seems to be a common ingredient of success. An alternative that seems to be gaining support is the country equivalent of a chief risk officer with responsibility for executing a country’s all-hazards plan and responsibility to report directly to the head of government.

...so that risk mitigation measures can be undertaken horizontally across government.

Country risk management tools

All-hazards policy frameworks can foster horizontal coordination across government bodies to help policymakers compare risks for the purpose of deciding what mitigation investments should be made to “buy” a risk down. Public investment to mitigate risks entails the expenditure of limited resources that need to be prioritised to maximise value. Decision-makers should be informed by a separate risk assessment based on comparable criteria, because the studies conducted within individual ministries tend to measure risks in terms that are practicable to their own mandates. Some countries have implemented tools such as a “National Risk Assessment” or capabilities-based planning to compliment their all-hazards policy approaches.

The UK has implemented the National Risk Assessment tool...

United Kingdom

In the wake of such events as the year 2000 computer scare, fuel protests in 2000 and foot and mouth disease outbreaks in 2001, the United Kingdom established the Civil Contingencies Secretariat (CCS) within the Cabinet Office of the Prime Minister. Its mandate is to improve the country’s capacity to absorb, respond to and recover from disruptive challenges. CCS functions include managing the “National Risk Assessment” (NRA), a tool to identify, assess and rank the risk of emergencies facing the whole country. Currently, the NRA identifies risks over a five-year period and plots approximately eighty hazards and threats into a risk matrix that helps ministries in their policy decisions about emergency preparedness and capability planning. The tool introduces a systematic and all-inclusive approach to risk analysis, wherein risk is defined as a function of the likelihood and impact of a given natural hazard or man-made threat.

This reflects, on the one hand the possibility of an emergency occurring which could adversely affect an organisation (eg flooding or nuclear accident), and on the other hand, the extent to which the event impacts upon the organisation (eg lack of staff, disruption to power supply, damage to facilities). Every three months CCS produces an assessment of near-term risks, on a rolling basis, which is also distributed across government. All risks over the next five years are fundamentally reviewed on an annual basis.

...with a three-stage reporting structure filtering up to government ministers.

The NRA process comprises three stages: identification of risks; assessment of the likelihood of the risks occurring and their impact if they do occur; and comparison of the risks. The process entails consultation with a wide range of participants from government departments, agencies, devolved administrations, and public, private and voluntary sector representatives. Provision is made to provide regular monitoring and updating mechanisms that take account of changes in the risk environment. For near-term events, CCS set-up a horizon scanning team to reinforce the country's ability to assess circumstances that may precipitate an emergency, communicate its assessment to key decision-makers and other parts of CCS, and assist in developing an integrated response. The team collects information through an extensive network of over 10,000 contact points in public and private organisations, attends seminars and reads pertinent literature to deliver written assessments. These reports go forward as issues are identified to the cross-government "Domestic Horizon Scanning Committee" and once approved are issued to senior government officials and ministers as an agreed assessment on which to inform decisions and planning.

The National Security Strategy is another three-stage process...

The Netherlands

The Netherlands' "National Security Strategy" (NSS) is a comprehensive plan designed to protect five national interests against potential catastrophic events: territorial safety, physical (human) safety, economic safety, ecological safety, and social and political stability. A whole-of-government work plan is produced for the government's Cabinet with specific preventative and preparatory measures designed to protect these national interests. The NSS is the result of a collaborative working method comprised of three phases: risk analysis (covering risk identification); strategic planning; and preventative policy and preparation. It is led by the Ministry of the Interior, but involves the participation of every ministry.

...with a greater focus on being a cabinet decision making tool.

This working method identifies catastrophic risks and elaborates incident scenarios along three time horizons (ie less than 6 months, 6 months – 5 years, more than 5 years). It then assesses the threats in terms of their risk to the vital interests mentioned above, and positions these risks vis-à-vis each other in the National Risk Assessment (NRA); which, as in the United Kingdom, is a two dimensional matrix plotting risks along axes for likelihood and impact. While the NRA inputs involve complex calculations and draw on intricate expert analyses, its output is a diagram designed for ease of use by ministers in the government Cabinet. The Cabinet decides what risks will be prioritised for detailed treatment in the strategic planning stage. This second phase is where the government determines what capabilities it would require to deal with all the prioritised risks and which capabilities it already possesses. The Cabinet then decides whether, where and how national security should be strengthened via policy, legislation and programmes proposed by ministries. Among the risks that have been identified as having potential for social disruption in the Netherlands are: flooding, pandemic flu, social radicalization, terrorist attacks, and energy or raw material supply scarcity.

Singapore's WOG-IRM framework corrects lack of ministerial risk awareness...

Singapore

Singapore adopted the “Whole-of-Government Integrated Risk Management” (WOG-IRM) framework to improve the risk awareness of all government agencies. Though most agencies already conducted internal audits to analyse risks that fall within their remit, it was thought that some agencies might not deliberately and systematically go about identifying the full range of risks, or may have under or over-estimated the likelihood and/or impact of the risks they manage. It was recognised that some government agencies might also lack an awareness of how such risks are affected by the action or inaction of other agencies, and vice versa. Moreover, specialised agencies often think in terms of risk avoidance, ie making sure they have the capacity to deal with unwelcome events or developments. The WOG-IRM framework helps address gaps in risk management and to identify cross-agency risks that may have fallen through gaps in the system. It helps agencies to address their own vulnerabilities and to identify previously unknown vulnerabilities that may result from disruptions to other agencies.

...and is tied to the budget cycle to allow greater quantification.

The implementation of WOG-IRM is tracked through the course of the year and aligned with the annual budget cycle, where priority fund allocations are awarded to proposals which address the key risks identified in the WOG-IRM. A Strategy Committee chaired by the Head of Civil Service provides oversight and guidance by serving as the main platform to steer and review the overall progress. The Committee meets quarterly and comprises Permanent Secretaries from the various ministries across government. Singapore's Ministry of Finance created a master list of strategies and associated risks within the WOG-IRM framework that are considered to have the potential to affect the Government's four strategic Outcomes: security, opportunity, identity. Enumerating strategic outcomes is similar in effect to the national interests stated in the National Security Strategy of the Netherlands. This practice should be lauded because it clarifies what the government's actions are actually trying to preserve or achieve, and it facilitates measuring successful policies and mitigation investments.

United States

US disaster management has been greatly influenced by major recent events...

In the wake of the attacks of September 11, 2001 the United States federal government underwent one of its largest ever institutional changes by merging 22 agencies and over 180,000 employees into the Department of Homeland Security (DHS) in 2002. This new super-ministry is meant to provide a unified core for the vast national network of organisations and institutions involved in preventing, protecting, responding to and reducing the impacts of terrorism. Since Hurricane Katrina struck in 2005, however, the focus of DHS has diversified, using a risk-based approach to manage the programmes it administers, thereby bolstering support for the full range of risks within its remit, including natural disasters.

...and now excels in monitoring and communication.

Where DHS excels is with its “Homeland Security Information Network”, a computer-based communications system, designed to collect and disseminate information between federal, state and local agencies. This communications capability delivers to states and major urban areas real-time interactive connectivity with the National Operations Center (NOC), which provides situational awareness and monitoring of the homeland, coordinates incidents and response activities, and issues advisories and bulletins concerning threats. The NOC operates 24 hours a day, seven days a week, 365 days a year, and coordinates information sharing to help deter, detect, and prevent terrorist acts and to manage domestic incidents.

The four above-mentioned countries use capabilities based planning to guide mitigation investments for the full range of their country risk portfolios, from terrorist attacks to pandemics. The benefits of such a systematic approach are the improved ability to set specific preparedness goals and priorities, to compare the costs and benefits of investment choices, and to evaluate preparedness results. Capabilities-based planning revolves around three axes:

- 1) The categorisation of specific means (capabilities) required to respond to a wide range of potential disruptive challenges;
- 2) The identification of the current level of capacity to deliver on response missions; and
- 3) Advice to policymakers in their decisions so that resources are directed to close the gap between the current and targeted capacities.

Japan

Japan has an inter-ministerial council...

The Central Disaster Management Council in Japan is an inter-ministerial body that brings together the entire Prime Minister's Cabinet and highly respected experts to formulate and execute the country's basic disaster management plan. The Council deliberates specific issues on disaster reduction such as overall coordination of countermeasures in addition to operational matters including state of disaster declarations. The tools and methods this group uses to prioritise mitigation investment are not well documented. It has at its service numerous research centres that gather and integrate data about earthquakes and floods into elaborate hazard, consequence and vulnerability maps. Susceptible areas can be targeted for hazard mitigation and warning; however, the maps do not provide a common, holistic awareness and decision support system that can be used as a practical tool in collaborating and coordinating response activities. Central government perceives the need for such a system of data collection that the national disaster management system could integrate as a common tool for risk analysis.

Canada

...while Canada's coordinating body reflects the country's federal nature.

In Canada, Federal-Provincial-Territorial (FPT) ministers responsible for emergency management established a permanent forum that meets annually to improve collaboration. Their work plan includes decisions related to implementation of the National Disaster Mitigation Strategy (NDMS), which aims to reduce the risks, impacts and costs associated with natural disasters, as well as more future-oriented risks such as climate change adaptation. In addition, the forum meets in joint sessions with FPT ministers responsible for justice to discuss issues such as the current threat environment and parliamentary review of the Anti-Terrorism Act. As in Japan, the actual method this group uses to set priorities is unclear, as is whether the inter-ministerial group uses risk analysis to direct spending on mitigation measures. However, to ensure accountability under the NDMS, the FPT ministers set annual priorities and performance expectations for projects it funds and results are monitored and reported upon.

The above examples illustrate the cross cutting institutional arrangements that governments have put in place to address the complexity of risks that do not fit neatly within the remit of any one department, or even one level of government. It is too early to fairly assess the effectiveness of these various approaches and tools, and it is safe to say that there is no one-size-fits-all approach to integrated country risk management. Nonetheless, there appear to be best practices that all countries can learn from, such as:

1. The means to identify all hazards facing the country, and a comparative assessment of their probability and impact that produce a rank of their importance over different time frames;
2. A process to assess current capabilities to respond to and recover from disaster events that actually occur;
3. Tools fit for use by decision-makers to target mitigation investments to risks that are deemed priorities based not only on their relative importance (high likelihood and potential consequence), but also on the level of present capabilities to deal with them.

Public-private partnerships

Public-private partnerships
are also important...

To adapt to the risks of the 21st century there is a need for new forms of partnership between governments, the private sector and individuals to prepare for crises in advance and to redistribute the burdens they incur. Such partnerships can improve the ability to model hazards, identify effective policy measures to reduce disaster damages and increase the capacity of insurers to provide coverage.

...for economies dominated by
the private sector...

The ownership and interdependencies flowing from critical infrastructure systems, for example, require extensive public-private cooperation to assess the need for protection investment and to provide such decisions with expert guidance. At least 80% of critical infrastructure is owned by the private sector in at least four of the above-mentioned countries. National forums for the protection of critical infrastructure act as a natural conduit to encourage private sector self-regulation as a complement to traditional control measures and thereby reinforce vertical integration of country risk management policies. Regulatory agencies, national security authorities, and public and private sector operators hold periodic meetings to share information for the assessment of interdependent vulnerabilities, development of strategic plans and agreement on review procedures.

...as undertaken by the Austrian
authorities following major floods
in the early 2000s...

Hochwasser Risikoflächen Austria (HORA) is another example of successful public-private partnership (PPP) on flood risk zoning and mapping in Austria, where massive damage from flooding occurred after heavy rainfalls in summer 2002. The insurance industry and public authorities in Austria signed a PPP-contract laying out a common project for the development of a public, common and admission-free risk zoning tool. The common goal was to create an open risk zoning platform for floods and earthquakes. The public authorities delivered geographic information system (GIS) basis data; modeling and development was done by the insurance and reinsurance industry. No direct exchange of any sort took place and the common result has been open to the public since June 1, 2006. There have been more than 15 million hits on the homepage so far, and improvements and development (hail risk) are still in progress.³

³ www.hochwasserrisiko.at

...and put into place by other authorities.

The Association of British Insurers and the British government recently reached an agreement on continued, wide scale availability of flood insurance.⁴ The agreement outlines actions that both government and the insurance industry will take over the long term. For the government these include, inter alia: Environment Agency publication of a more detailed National Flood Risk Assessment to be published in 2009 and an annual review there-after; a long-term investment strategy to reduce river and coastal flood based on scenarios modelling of flood risk management to be published in 2009; publication of the number of planning applications approved against Environment Agency advice; ensuring that the planning system prevents inappropriate development in flood-risk areas; encouraging property owners to take sensible precautions; providing more information about how to obtain flood insurance; and promoting access to home insurance for low-income households.

Holistic government management programmes are becoming increasingly common...

Challenges remain

The needs of country risk management have undergone important changes over the past 50 years, and new approaches are still in their infancy. While whole-of-government approaches are becoming more widely used, risk-based tools to support mitigation investment decisions are rare, and they face considerable challenges. It is difficult to mobilise appropriate expertise and to marshal political willingness to act on the findings. Certain countries have purposefully resisted the impulse to centralise risk management functions in a single institution, since local actors will always be responsible for the first response to a disastrous event, and it is more effective, they argue, to bolster local capacity for risk analysis and response than to centralise these functions. Moreover, administrative reshuffling does not by itself break down barriers to efficient information exchange and policy coordination. Similar to corporate mergers, a pro-active programme of integration is needed to overcome different working cultures, data standards, communication protocols and lack of familiarity in working together.

...to manage an evolving risk landscape.

Governments clearly have their work cut out for them to live-up to the duties associated with providing security to persons, assets and the environment, but there are numerous examples of best practice around the world to be shared. Governments owe it to their citizens to honestly assess whether their country's risk management strategies are effective and efficient and to inform themselves whether actions taken in different countries hold valuable lessons for their own policies. In view of the vulnerabilities arising from interconnectedness, governments would do well to look beyond their own borders for partners to develop coordinated policy responses and mitigation interventions. The OECD stands ready for use as a forum for information exchange and to facilitate collaborative projects on country risk management such as its current study on "Future Global Shocks".

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⁴ Her Majesty's Government, Association of British Insurers (July 2008), FINAL-AGREEMENT.

Catastrophe financing in middle- and low-income countries: Framework and operations of the World Bank Group

Oliver Mahul – Natural catastrophes can not only cause loss of life and property in emerging and developing economies; the public and private costs of post-disaster reconstruction can impose massive strains on countries with limited capacity to absorb such financial losses. Relief and recovery programmes must be put in place to allow for eventual reconstruction. Governments can seek to transfer some of this risk through encouraging private insurance; creating public-private risk bearing partnerships; using capital markets through insurance lined securities; and agreeing contingent financing facilities with lenders such as the World Bank. A number of innovative disaster financing schemes have been set up in recent years by emerging and developing countries prone to natural catastrophes. These catastrophe risk financing frameworks have frequently been constructed in coordination with the World Bank.

1. Introduction

1. Countries have increasingly requested World Bank Group (WBG) assistance in **ex ante catastrophe risk financing**, reflecting greater concentration of assets and people in disaster-prone areas, and a growing frequency and intensity of hydro-meteorological events caused by climate change. When disasters strike, countries with limited economic resilience often seek assistance from the international donor community and/or divert funds from development projects to cover emergency and recovery needs. The ability of countries to reduce their vulnerability to natural disasters and limit their fiscal exposure is becoming a priority, as part of a shift from post-disaster assistance to ex ante catastrophe risk financing.

2. Catastrophe risk markets remain hampered by market and regulatory imperfections that limit their expansion, particularly in emerging countries. Market solutions in developing economies are often inhibited due to a range of issues such as undeveloped risk market infrastructure, misaligned incentives arising from pricing and regulatory structures, information issues and pricing.

3. The WBG has an interest in enabling the development of cost-effective catastrophe risk financing mechanisms given the fiscal and developmental implications of natural disasters in middle- and low-income countries. The WBG operations in catastrophe risk financing have largely been market-enhancing, aimed at correcting market and regulatory imperfections that impede the development of competitive catastrophe risk markets in emerging economies. The WBG has responded to catastrophe risk market incompleteness by developing a methodology and a supporting suite of products and services.

4. The WBG operations on catastrophe risk financing aim at improving the response capacity of the countries in case of natural disasters, while maintaining their fiscal balance. In addition to the enormous human toll, natural disasters can create enormous strain on the budget of an affected country. The WBG assists middle- and low-income countries in the development of domestic catastrophe insurance markets (including property insurance and agricultural insurance), thus promoting the transfer of catastrophe risks from households and/or enterprises to private insurers. The WBG also assist countries in the financial management of the fiscal impact of natural disasters in order to improve their response capacity in case of disasters while maintaining their fiscal balance.

5. The WBG operations on catastrophe risk financing is part of a broader proactive and strategic framework for disaster risk management. The underlying principles of the strategic framework are that the economic impact of disasters can be reduced by advance planning and cost-effective investment. The disaster risk management (DRM) framework includes risk assessment, institutional capacity building, risk mitigation investments, emergency preparedness and catastrophe risk financing.

6. The WBG has developed a Country Catastrophe Risk Financing Framework. This framework relies on three operational pillars that include country economic and fiscal catastrophe risk assessment, the promotion of domestic property catastrophe insurance markets, and the financing of sovereign catastrophe risk.

7. The WBG has been working for a decade to assist member countries in establishing catastrophe risk financing mechanisms that can increase insurance penetration and “crowd in” the private insurance and capital markets. In 2000, the WBG technical assistance supported the establishment of the Turkish Catastrophe Insurance Pool. Since then, the WBG has been involved in more than 40 catastrophe risk financing operations. They include the India weather-based crop insurance programme, the Mongolia index based livestock insurance programme, the Caribbean Catastrophe Risk Insurance Facility (CCRIF) and the Malawi weather derivatives intermediation. Contingent loans, such as the Development Policy Loans (DPL) with a Catastrophe Risk Deferred Drawdown Option (CAT DDO), have been signed with Costa Rica, Colombia and Guatemala. These operations have provided insurance coverage to more than three million households and more than twenty governments for an aggregate sum insured exceeding USD 71 billion.

8. The WBG has promoted three complementary business models to assist member countries in the financing of natural disasters. Through market facilitation, the WBG provides technical assistance and capacity building to member countries to facilitate access to catastrophe reinsurance and capital markets. Through market intermediation, the WBG allows member countries to place sovereign catastrophe risk on capital markets. Through Capital Provision, the WBG provides contingent lending products to the International Bank for Reconstruction and Development (IBRD) countries and equity investment in private insurance and reinsurance companies in middle- and low-income countries.

2. Catastrophe risk financing framework

9. By ensuring that sufficient liquidity is available in the aftermath of a disaster, *ex ante* catastrophe risk financing approaches can help speed recovery and ensure that scarce government funds are efficiently used. It can also assist countries to achieve the optimal allocation of risk in the economy, resulting in higher economic growth, better mitigation and more effective poverty alleviation.

10. The WBG has developed a Country Catastrophe Risk Financing framework. It is one of the five components of the disaster risk management framework promoted by the WBG. It is partly based on corporate risk management principles but also considers economic and social factors such as the government’s fiscal profile and the living conditions of the poor (Pollner 2001, Gurenko and Lester 2003, Pusch 2005, Ghesquiere and Mahul 2007, Cummins and Mahul 2008). This framework is based upon three pillars:

- *Assessing country fiscal liability due to natural disasters.* The contingent liability of the government due to natural disasters is often implicit, as the law usually does not clearly define the financial responsibility of the government when a disaster hits the country. The government thus acts as the risk carrier of last resort, without knowing precisely its catastrophe risk exposure. Understanding the loss potential of natural disasters and the extent of public intervention in recovery efforts can help governments ascertain their contingent liabilities.
- *Promoting domestic property catastrophe risk insurance markets.* Private competitive insurance solutions for the transfer of catastrophe risks can be encouraged by creating an enabling environment that allows private insurers and reinsurers to offer competitive products on domestic markets. Where necessary, this can include the establishment of catastrophe insurance programs based on public-private partnerships (such as catastrophe insurance pools).
- *Financing sovereign catastrophe risk.* The government can manage its remaining fiscal contingent liability arising from natural disasters by promoting the insurance of public assets and by protecting its budget against liquidity crunches through sovereign risk financing.

11. In addition to the enormous human toll, natural disasters generally create enormous strain to the budget of an affected country. The budgetary implications can be derived from the financing needs faced by a government during the three main phases of post-disaster operations.

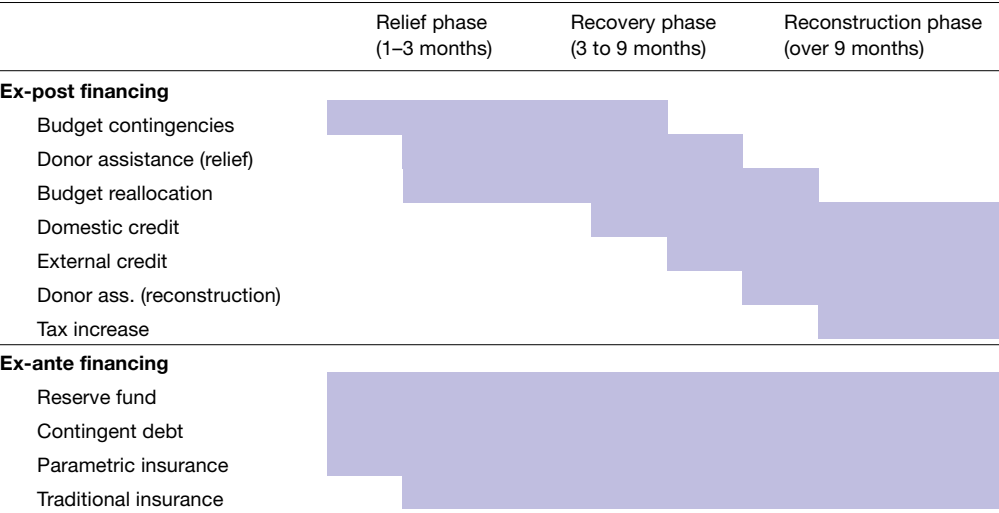
- *Relief operations* include emergency assistance provided to the affected population to ensure basic needs, such as the need for shelters, food and medical attention. This is the provision of emergency services and public assistance during or immediately after a disaster in order to save lives, to reduce health impacts, to ensure public safety and meet the basic subsistence needs of the people affected. This phase aims at stabilising society, with termination of further loss. Such costs can be difficult to estimate ex ante, as they depend on the specific characteristics of the catastrophic event (location, intensity, period of the year (winter or summer), period of the day (day or night), etc.), but are relatively small compared to the subsequent recovery and reconstruction operations. These expenditures can be estimated based on scenario analysis as recently completed by the Directorate for Prevention and Emergency Response in Bogotá DC, Colombia (Ghesquiere, Jamin and Mahul, 2006). While relief costs are limited, they need to be financed in a matter of hours after a disaster event. The capacity of governments to mobilise resources for relief operation at short notice should be a key component of their risk financing strategy.
- *Recovery operations* following the initial relief efforts are crucial to limit secondary losses and ensure that reconstruction can start at earliest. They are the restoration and improvement, where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors. That is, the society's functions are restored, such as re-opening of schools, businesses, etc, even if only in temporary shelters. They include, among other things, the emergency restoration of lifeline infrastructure (eg, water, electricity and key transportation lines), the removal of debris and the financing of basic safety nets. It is also during this phase that engineering firms can be mobilised to start the design of infrastructure works that will have to take place during the reconstruction phase. Several techniques exist to estimate the likely cost of recovery operations.

Catastrophic risk models can simulate the impact of natural disasters, such as earthquake, on infrastructure and thus provide rough estimates of the lifeline infrastructure that is likely to be damaged in case of a major disasters. Such models can also be used to assess the number of people that are likely to become homeless and the number of buildings that will have to be rebuilt.

- *Reconstruction operations* generally centre on the rehabilitation or replacement of assets damaged by a disaster. They include repair and rebuilding of the housing, industry, infrastructure and other physical and social structures that comprise that community or society. These include public building and infrastructure which are the direct responsibility of the state. At the same time, it is important to note that national or municipal authorities generally have to face obligations that go beyond their own assets. In most cases, government will have to subsidise the reconstruction of private assets and in particular housing for low-income families who could not otherwise afford to rebuild their homes. Here again, catastrophe risk modeling techniques can be used to estimate the potential damage to the infrastructure and public and private dwellings. They can provide, for each group of assets, risk metrics such as the probable maximum loss for a given return period, which can help the authorities assess the budgetary needs caused by potential catastrophic events. The use of scenario analysis coupled with risk models can also help authorities better understand their potential needs over time.

12. Governments have various ex ante and ex post instruments to finance natural disasters. In the aftermath of a disaster, immediate expenditure needs are high, but immediately available financial resources are usually limited, creating a liquidity gap. Over time, more post-disaster resources become available, allowing the government to address its financial needs. Although there are a wide range of instruments for financing long-term expenditures, the financing of short-term needs is more challenging (see Figure 1).

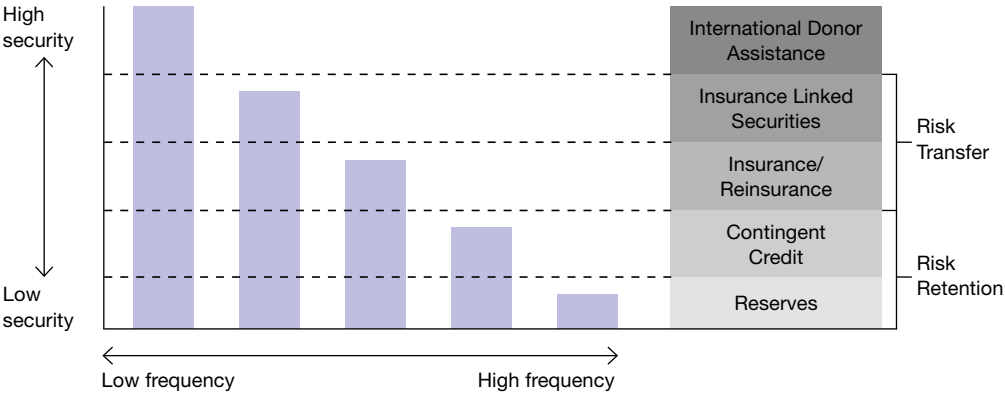
Figure 1:
Availability of financial instruments



Source: Ghesquiere and Mahul (2007)

13. A country catastrophe risk financing strategy relies on an optimal combination of risk retention and risk transfer instruments, based on the desired coverage and available budget. Small and recurrent losses could be retained through a national reserve fund, possibly complemented by contingent credit. More severe but less frequent losses can be covered by insurance and/or reinsurance. Risks from major natural disasters can be transferred to the capital markets through insurance-linked securities such as catastrophe bonds. International donor assistance remains essential for the financing of extreme events (see Figure 2).

Figure 2:
Catastrophe risk layering



Source: Cummins and Mahul (2008)

14. Capacity building and technical assistance are essential to increase the awareness and understanding of member countries about catastrophe risk financing solutions. Catastrophe risk financing is a relatively new area for many member countries and, therefore, local capacity building is essential to ensure that the member countries understand the benefits and limitations of catastrophe risk financing solutions as part of their comprehensive disaster risk management strategy.

3. WBG operations on catastrophe risk financing

WBG products and services on catastrophe risk financing

15. The WBG has developed a methodology and a suite of catastrophe risk financing products and services that are designed to help governments develop private domestic property catastrophe insurance markets and efficiently aggregate and transfer catastrophe risks to international capital and reinsurance markets. They rely on the WBG's intricate knowledge of the member countries, its in-house expertise, and the reputation of impartiality with the countries and the international capital and reinsurance markets.

16. The WBG offers a complementary suite of products and services to assist member countries develop tailor-made catastrophe risk financing strategies through an optimal combination of financial instruments. The products and services on catastrophe risk financing offered by the WBG can be classified into three main categories (see Table 1):

- *Sovereign catastrophe risk financing.* The WBG provides products and technical assistance that allow countries to secure immediate liquidity and budget support following a major natural disaster.
- *Property catastrophe risk insurance.* The WBG works with member countries to develop competitive catastrophe insurance markets and increase property catastrophe insurance penetration among homeowners and small and medium-sized enterprises.
- *Agricultural insurance.* The WBG assists its member countries in the development of agricultural insurance programs for farmers, herders and agricultural financing institutions (eg, rural banks, microfinance institutions).

17. WBG operations on catastrophe risk financing have been “market enhancing”. The market-enhancing view recognises that market failures can create sub-optimal allocations of resources and that private sector coordination is not always effective. Public policy should facilitate the development of risk market infrastructure that enables market-based solutions, such as the creation of public goods and the provision of technical assistance. Government institutions can be invoked in specific circumstances where risks are ill-defined and private market solutions are not feasible (see Table 1).

Table 1: WBG Catastrophe Risk Financing Products and Services

	Sovereign Cat Risk Financing (governments and public entities)	Property Catastrophe Insurance (households, SMEs, financial institutions)	Agricultural Insurance (farmers, herders, rural financial institutions)
Capital Provision			
Contingent loans	☑		
Market Intermediation			
Catastrophe bonds/swaps	☑		
Weather derivatives	☑		
Market Facilitation (Technical Assistance, Capacity Building)			
Catastrophe risk pools	☑	☑	☑
Legal and regulatory framework	☑	☑	☑
Index-based insurance product development	☑	☑	☑
Indemnity-based insurance product development	☑	☑	☑

Source: WBG Catastrophe Risk Insurance Working Group (2009)

18. Over the last decade, the WBG has assisted member countries in developing catastrophe risk financing programmes which currently protect more than three million households for a total coverage exceeding USD 71.6 billion (see Table 2). Sovereign catastrophe risk financing solutions have been implemented with governments in more than twenty countries, for a total insurance coverage of USD 887 million. Sixteen of these countries are covered under the Caribbean Catastrophe Risk Insurance Facility. The Turkish Catastrophe Insurance Pool, which offers property earthquake insurance to home-owners, provides coverage to about 2.5 million households for a total sum insured of about USD 70 billion. It is the largest WBG catastrophe risk insurance operation in terms of numbers of insureds and insurance coverage. Agricultural insurance programs supported by the WBG covered approximately 607,000 farmers in 2008, mostly through the India weather based crop insurance scheme, for a total sum insured of about USD 391 million.

Table 2: WBG Catastrophe Risk Financing Programmes (as of October 2009) Performance Indicators

WBG-supported operations (year of implementation)	Number of Insureds	Catastrophe (US\$ million)	WB lending operation (US\$ million)
Sovereign Catastrophe Risk Financing			
Catstrophe Bond (2005)	Government of Mexico	160.00	–
Catstrophe Bond (2009)	Government of Mexico	290.00	–
Caribbean Catastrophe Risk Insurance Facility	16 Caribbean Island Governments	500.00	14.20
DPL with CAT DDO (2008)	Government of Colombia	150.00	150.00
DPL with CAT DDO (2008)	Government of Costa Rica	65.00	65.00
DPL with CAT DDO (2009)	Government of Guatemala	85.00	85.00
Weather Derivates (2008)	Government of Malawi	5.00	–
<i>Total</i>	<i>21 governments</i>	<i>1 255.00</i>	<i>314.20</i>
Property Catastrophe Insurance			
Turkish Catastrophe Insurance Pool (2008)	2 500 000 homeowners	70 000.00	180.00
<i>Total</i>	<i>2 500 000 homeowners</i>	<i>70 000.00</i>	<i>180.00</i>
Agricultural Insurance			
India weather-based crop insurance (2003)	600 000	370.00	–
Mongolia index-based livestock insurance (2005)	3 700	17.00	7.75
Malawi weather-based crop insurance (2005)	2 600	2.50	–
Central America weather-based crop insurance (2007)	100	1.60	–
Thailand weather-based crop insurance (2007)	400	0.30	–
<i>Total</i>	<i>606 800 farmers/herders</i>	<i>391.40</i>	<i>7.75</i>
Grand Total		71 646.40	501.95

Source: WBG Catastrophe Risk Insurance Working Group (2009)

Sovereign catastrophe risk financing

19. The WBG provides products and services that allow member countries to secure immediate liquidity and budget support following a major natural disaster. They include contingent loans, regional sovereign catastrophe insurance pools, and capital market intermediation.

Contingent loans

20. DPL with CAT DDO is a development policy loan that offers IBRD-eligible countries immediate liquidity up to USD 500 million or 0.25 percent of GDP (whichever is less) if they suffer a natural disaster (Operational Policies [OP]/Bank Procedures [BP] 8.60). It offers bridge financing while other sources of funding are being mobilised. Funds will be disbursed when a country suffers a natural disaster and declares a state of emergency. Eligible borrowers must have an adequate macroeconomic framework in place at inception and renewal and a disaster risk management programme that is monitored by the WBG.¹

21. The first DPL with CAT DDO was approved in September 2008 by the World Bank's Board of Executive Directors. The USD 65 million loan aims to enhance the Government of Costa Rica's capacity to implement its Disaster Risk Management Program for natural disasters. The Government of Costa Rica drew down USD 15 million after the 6.2 magnitude earthquake that hit Costa Rica on January 8, 2009.

22. A USD 150 million DPL with CAT DDO was approved for Colombia in December 2008. It replaces the current contingent IBRD investment loan contracted in 2005. USD 85 million DPL with CAT DDO was approved for Guatemala in May 2009.

Regional catastrophe insurance pools

23. The WBG provides advisory services to help member countries access the international reinsurance and capital markets. The WBG has recently assisted sixteen Caribbean countries in establishing the Caribbean Catastrophe Risk Insurance Facility (CCRIF), a Caribbean-owned, regional institution which offers parametric insurance, akin to business interruption insurance, against major hurricanes and earthquakes. The CCRIF is the result of two years of collaborative work between Caribbean Community (CARICOM) governments, key donor partners and the WBG. The Facility became operational on June 1, 2007.

24. The financial capacity of the CCRIF relies on its own reserves and on reinsurance. The donor community contributed to the initial reserves of the CCRIF for approximately USD 67 million, and the CCRIF participants paid one-time participation fees of USD 22 million. Participating countries paid in 2008 a total premium volume of USD 30 million for an aggregate coverage of USD 601 million. The CCRIF successfully placed more than USD 132.5 million of coverage on the international reinsurance and capital markets in 2009.

¹ Memorandum to the Executive Directors, Proposal to Enhance the IBDR Deferred Drawn Down Option (DDO) and to Introduce a DDO Option for Catastrophic Risk, January 29, 2008. The Executive Directors approved the DPL with CAT DDO on March 4, 2008.

The reinsurance strategy of the CCRIF is designed to sustain a series of major natural disasters events (with a probability of occurrence lower than 0.1 percent), achieving a higher level of resilience than international standards (usually set up at 0.4 percent).

25. The CCRIF has been welcomed by the international reinsurance and capital market. It offers the reinsurance and capital market a transparent and efficient vehicle to access new business opportunities in the Caribbean region.²

26. Sixteen countries are currently participating in this catastrophe insurance program: Anguilla, Antigua & Barbuda, Bahamas, Barbados, Belize, Bermuda, Cayman Islands, Dominica, Grenada, Jamaica, St Kitts & Nevis, St Lucia, St Vincent & the Grenadines, Trinidad & Tobago, Turks and Caicos Islands, and Haiti. USD 14.2 million of International Development Association (IDA) special credits were provided to the Governments of four Caribbean island countries (Dominica; Grenada; St Lucia; and St Vincent and the Grenadines) to finance their entry fees and the payment of the annual insurance premium during the first years of operation. Similarly, a USD 9 million IDA grant was provided to the government of Haiti.

27. The feasibility of a similar vehicle is being investigated for the Pacific region, at the request of the Pacific Island Countries.

Insurance-linked securities intermediation

28. The Government of Mexico, with the technical assistance of the WBG, issued in 2006 a catastrophe bond, the Cat-Mex bond, with a historically low interest spread. The Government of Mexico established a self-insurance fund, called FONDEN, in 1996 to finance emergency needs in the aftermath of a disaster. The Ministry of Finance decided to develop a risk-financing strategy for FONDEN, relying on market-based financial instruments, in order to make FONDEN less dependent on the government for the allocation of post-disaster funds. The government decided to focus on major risks such as earthquakes, which could potentially cause up to USD 10 billion of losses, if a major earthquake hit Mexico City. In March 2006, Mexico purchased a USD 450 million catastrophe coverage, of which USD 160 million was issued as a catastrophe bond, to cover against the risk of earthquakes. This bond, which has been sold to institutional investors in the United States and Europe, acts like an insurance policy for the Mexican government. Investors paid USD 160 million into a single-purpose reinsurer created for the Government of Mexico. If an earthquake of a specified magnitude occurs in designated areas of the country within the next three years, the government will be able to draw from these funds. If no disaster occurs during the life of the fund, the money will be returned to the investors. This is the first time a sovereign country has issued a catastrophe bond.

² The CCRIF received the Reinsurance Initiative of the Year award in September 2008 in recognition of the reinsurance initiative that has generated the most promising change to a significant area of business. The CCRIF was also nominated as "Transaction of the Year" at the Insurance Day London Market Awards in December 2008.

29. A multi-peril catastrophe bond was issued in October 2009 for an amount of USD 290 million. This cat bond, intermediated by the WBG, protects the Government of Mexico against major losses caused by earthquakes and/or hurricanes. This product is part of a broader initiative of the WBG to offer the member countries a platform to access catastrophe insurance markets, provide multi-year coverage (at fixed rates), reduce costs through efficient transfer of risk to capital markets, allow countries to pool their risks to potentially lower further insurance costs, and enable rapid payments post event based on parametric insurance.

30. As part of the reinsurance placement of the CCRIF, the WBG placed a portion of the catastrophe risk in the capital markets through a cat swap in 2007 and renewed it in 2008 and 2009. The USD 20 million swap between IBRD and CCRIF was the first transaction to enable emerging countries to use a derivative transaction to access the capital market to insure against natural disasters. It was also the first time a diversified pool of emerging-market countries' catastrophe risk was placed in the capital markets.

Weather derivatives intermediation

31. Since June 2008, the WBG has been able to intermediate weather derivatives to facilitate IDA and IBRD countries' access to the weather derivative markets. In October 2008 the WBG intermediated a weather risk management derivative which was designed to help Malawi protect itself against the risk of severe drought. This is the first time that an IDA member has been able to access a risk management product through the WBG Treasury. The UK Department of International Development (DFID) provided financial support to the Government of Malawi to cover the cost of the contract. The weather hedge for Malawi is part of a larger framework designed to reduce agricultural risk in the country. Malawi suffers from chronic drought that cuts agricultural yields, depresses farmer incomes, and creates contingent liabilities for the government. The weather derivative is an option on a rainfall index which links rainfall and national maize production. If precipitation falls below a certain level during the coverage period (October to May), the index will reflect the value of the projected loss in maize production. The maximum on the contract is USD 5 million.

32. Weather risk management transactions can be adapted to countries' specific needs, depending on the type of weather hazard, level of protection, and the estimated financial loss associated with a severe and catastrophic event. The potential application of this product spans diverse sectors, eg, agriculture, energy production and tourism.

National catastrophe insurance facility for public assets

33. The WBG assists countries in the review of the catastrophe risk exposure of the public assets and infrastructure and in the development of effective and affordable catastrophe insurance programs for public assets. Technical assistance is ongoing in Colombia, Costa Rica and Mexico.

Property catastrophe risk insurance

National catastrophe insurance pool

34. The Turkish Catastrophe Insurance Pool (TCIP) was established with WBG technical and financial support in the aftermath of the 1999 Marmara earthquake. This pool enables the government of Turkey to: i) ensure that all-property-tax-paying domestic dwellings can purchase affordable and cost-effective earthquake insurance coverage; ii) reduce the government's contingent fiscal exposure to recurrent earthquake by guaranteeing funds for the rehabilitation of public infrastructure and by relieving pressure on the government to provide housing subsidies in the aftermath of an event; and iii) transfer catastrophe risk to the international reinsurance markets.

35. It offers efficiently priced earthquake insurance to homeowners. The WBG provided the initial capitalisation of the TCIP through a committed contingent loan facility of USD 100 million, extended to USD 180 million in 2004. The full risk capital requirements of TCIP are funded through commercial reinsurance (currently close to USD 2 billion) and the build-up of surplus. The TCIP sold more than 2.5 million policies set at market based premium rates (ie, 22% penetration) in 2007, compared to 600,000 covered households when the pool was set up.

36. The TCIP provided an important demonstration of the feasibility of national catastrophe insurance pools, with strong involvement of the private sector. To date, inspired by TCIP's example, more than a dozen countries – including China, Colombia, Bulgaria, Serbia and the Philippines – have started technical and legislative work towards the preparation of catastrophe insurance programmes. Romania enacted a compulsory catastrophe insurance law on October 8, 2008 after four years of WBG technical and financial assistance to the government. The Romania Catastrophe Insurance Pool, which provides homeowners with coverage against earthquake and flood risks, is expected to be operational in 2010.

Regional catastrophe reinsurance pool

37. The proposed South Eastern Europe Catastrophe Risk Insurance Facility is expected to be set up as a public-private partnership whose main objectives are to facilitate the development of the catastrophe insurance market in Europe and Central Asia (ECA) countries and thereby provide access for homeowners and small and medium-sized enterprises to affordably priced (but not subsidised) catastrophe indemnity-based insurance across the ECA region. It is envisaged that the programme will initially provide coverage to the countries of Southeastern Europe and thereafter to countries of Central and Eastern Europe.

38. The Facility will act as a regional catastrophe reinsurer, incorporated in Switzerland, and will provide reinsurance for catastrophe risks underwritten by ECA insurers under the programme. The WBG is providing technical assistance and lending to ECA countries to enable them to make their capital contributions to the Facility.

Agricultural insurance

39. Since the late 1990s, dwindling public support to agricultural producers in emerging markets has led to a renewed interest in agricultural insurance. The development of agricultural risk modeling techniques and the emergence of insurance pools as well as index-based insurance contributed to a revisiting of the potential role of agriculture insurance in emerging economies with the objective of helping agricultural sectors become more profitable and commercially oriented.

40. The WBG has provided technical assistance for the development of innovative agriculture insurance programmes in both low and middle-income countries. These programmes are included in broader efforts of agricultural risk management. They are often connected to agricultural finance support efforts and tied to complementary efforts in agricultural extension.

Agricultural insurance pool

41. A livestock insurance pool has been piloted since 2005 by the Government of Mongolia, with the assistance of the WBG and donors, to protect herders against excessive livestock mortality caused by harsh winters and summer drought. The Mongolian programme involves a combination of self-insurance by herders, market-based insurance and social insurance. Herders retain small losses, larger losses are transferred to the private insurance industry, and extreme or catastrophic losses are transferred to the government using a public safety net programme. The Livestock Insurance Indemnity Pool (LIIP) was established to provide livestock mortality coverage to the herders. Through this pool insurance companies have built collective reserves and the government has offered public reinsurance, backed by a USD 5 million WBG contingent credit facility.

42. The insurance program relies on a livestock mortality-rate index by species in a local region (soum). The insurance pays out to individual herders whenever the mortality rate in the soum exceeds a specific threshold. Under the programme, individual herders receive an insurance payout based on the local mortality, irrespective of their individual losses.

43. The viability of index-based livestock insurance is being piloted in 2005–09 in selected areas to test the preparedness of private insurance companies to offer this product and the herders' willingness to purchase. In the third sales season (April–July 2008) about 600,000 animals were insured, representing 14 % insurance penetration, for a total premium volume of USD 120,000. The 2008 season saw a major loss of USD 230,000 (almost twice the premium volume), which triggered the IDA contingent credit. The programme is expected to be expanded to another province in 2009 and then nationwide by 2012.

Index-based crop insurance products

44. The interest in using index-based agricultural insurance has grown in recent years, particularly with respect to addressing the systemic component of agricultural production losses (such as those caused by a widespread drought). Index-based insurance offers advantages over traditional insurance relying on individual losses, including lower monitoring costs and more transparent indemnity structures. However, this type of insurance faces some challenges (such as basis risk), which makes it cost-effective only for specific crops, perils and geographical areas.

45. Index-based agricultural insurance relies on the measurement of an objective and independent parameter that is highly correlated with the actual loss incurred by a farmer. Measurements such as rainfall or temperature are used as a proxy for such yield loss. Under parametric index insurance, payouts are based solely on the measurement of a particular parameter (for example, rainfall at a named meteorological station) according to an agreed payout scale (established in the insurance policy) related to the rainfall actually recorded at a specific meteorological station. Under aggregate index insurance, payouts are based on an index developed from the aggregated statistics of farm production or yield in specified districts (for example, area yield statistics for crops, or mortality index for livestock).

46. The implementation of index based insurance in agriculture is relatively new and a number of projects have been piloted in lower-income countries. Approximately 20 index-based agricultural insurance pilot programmes have been implemented in low and middle-income countries to date.

47. The WBG has assisted the Government of India in the implementation of the Modified National Agricultural Insurance Scheme (MNAIS). This crop insurance programme offers coverage against crop yield losses to India farmers, using an area-yield index in the indemnity payment schedule. To date, about 20 million farmers have been insured under this programme, for a total liability of USD 7 billion, making this the largest crop insurance programme in the world in terms of insured farmers. The WBG has provided the government of India with non-lending technical assistance to move this scheme to an actuarial regime, in order to make it more attractive to farmers and reduce the fiscal exposure of the government.

48. The WBG has also assisted the government of India in the development of the Weather Based Crop Insurance Scheme (WBCIS). This scheme protects farmers against specific adverse natural events (eg, rainfall deficiency, excess rainfall, low temperature) through weather-based insurance. More than 600,000 farmers purchased weather-based crop insurance in 2007 in India. This program draws on small-scale weather-based insurance pilots conducted in India with WBG's technical assistance since 2003.

49. Weather-based crop insurance has been piloted in Malawi since 2005 as a means to manage weather-related risks of providing credit to farmers. During the 2008–09 season, about 2,600 farmers were covered with a sum insured of USD 2.5 million. The Central American weather risk management programme has been developed in Honduras, Guatemala and Nicaragua. The programme is currently only operating in Nicaragua, where 2,500 hectares of export crop, with a value of USD 41.6 million, were insured in 2008. In Thailand, weather based crop insurance is being offered on a pilot basis to 400 farmers for a total sum insured of USD 300,000. Other excess/deficit rainfall projects are under development in Kenya, Ethiopia and Senegal. The feasibility of other applications of index-based insurance is being assessed in Indonesia, Burkina Faso, Bangladesh and Jamaica. These weather-based crop insurance pilots are linked to agricultural lending and aim to strengthen agricultural finance, agricultural supply chains and profitability in agriculture.

50. Training materials and case studies have been developed by the WBG to support capacity building in index-based insurance contract design and pricing and in agricultural insurance programme management.

Specialised index-based facility

51. The WBG is managing the creation of the Global Index Insurance Facility (GIIF), a multi-donor trust fund which promotes index-based insurance in developing markets.

52. The Technical Assistance Program is established through the GIIF Trust Fund (GTF), which supports local insurance companies and other private institutions in order to ensure an open and broad development of the market. Its main activities are:

- Financial assistance to partner financial institutions to develop the tools to quantify, assess, underwrite, retain and reinsure index-based risks in developing countries;
- Local commercial capacity building to develop capacity in local markets for index-based insurance instruments;
- Provision of performance-based premium support to facilitate the introduction of market solutions for index-based products for a limited period within pre-defined parameters.
- Regulatory and policy technical assistance and capacity building related assistance to promote the development of index-based insurance.

53. Donor funding has been secured, including EUR24.5 million from the European Commission to support the development of index-based insurance in African, Caribbean and Pacific (ACP) countries.

4. Lessons from WBG operations on catastrophe risk financing

54. Some basic principles can guide the WBG operations in catastrophe risk financing, based on the lessons drawn from WBG experience. The guiding principles reflect the need to develop competitive and sustainable catastrophe insurance in middle and low-income countries and facilitate access to international reinsurance and capital markets.

- *Promote catastrophe risk financing in the dialogue on disaster risk management with low and middle-income countries.* Disaster risk management should become part of a wider dialogue with countries regarding macroeconomic stability and growth. The lack of disaster risk financing can have a significant impact on fiscal discipline, on debt sustainability and on country ratings. Catastrophic risk financing solutions, including insurance, should be encouraged within the five-pillar DRM framework.
- *Enhance competitive catastrophe insurance and reinsurance markets.* The WBG can contribute to creating more efficient and competitive insurance and reinsurance markets. An effective legal and regulatory framework is needed to support competitive markets. Public-private partnerships can stimulate the development of competitive domestic insurance industries and facilitate access to international reinsurance and capital markets as a means of generating cost-effective and affordable insurance solutions for private agents as well as governments.
- *Use risk-based price signals to encourage disaster risk management.* In competitive markets, insurance premiums should be risk-based and differentiated, thus reflecting the underlying risk exposure. These draw attention to the catastrophe risk exposure of individuals, firms or governments, and allow them to evaluate the benefits of a disaster risk management programme by comparing the cost of risk reduction investments with the resulting reduction in potential losses. In this context, premium subsidy programmes should be limited to those that minimise distortions of market price signals.
- *Develop customised catastrophic insurance solutions.* Risk financing solutions typically need to be tailored to specific local conditions. The WBG assistance in the financing of natural disasters should be tailored to country-specific variables, including country risk exposure, the country's ability to diversify risks spatially and across time (for example, debt level, tax base), the degree of development of the domestic insurance market, access to international (re)insurance and capital markets.

55. The WBG has played four key roles in the development of catastrophe insurance solutions for developing countries (Cummins and Mahul 2008):

- *Business interface.* Using their convening power with countries and the international reinsurance market, the WBG can play a catalytic role in the development of efficient partnerships among countries, donors and private markets for the financing of catastrophic risks.
- *Promoter of public goods.* WBG can play a major role in supporting public goods that contribute to the creation of a risk market infrastructure, which facilitates the development of market-based risk financing solutions. Public goods include information collection and management systems, catastrophic risk assessment programmes, risk modeling development programmes, awareness and education campaigns, and institutional capacity building.

- *Provider of technical assistance and capacity building.* WBG can promote the emergence of innovative risk financing solutions, including index-based insurance products, catastrophe insurance pools (eg, LIIP, TCIP, CCRIF), and risk transfer vehicles (such as reinsurance, catastrophe bonds, weather derivatives) through technical assistance, and local and institutional capacity building.
- *Financier.* WBG provides specific lending products, such as the DPL with CAT DDO, provides intermediation on capital markets (through Treasury), and makes equity investment in insurance companies.

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Integrative risk management for the public sector:

The role of (re)insurance in providing innovative risk transfer solutions

Raj Singh, Reto Schnarwiler, David Bresch – We face constant reminders that natural disasters are unforeseeable in their timing and unpredictable in their impact. Disasters like these can cost dearly in terms of the lives they claim. They reverse economic activity and also leave a massive economic and financial burden for governments, who are sometimes ill-prepared to cope, and ultimately for taxpayers. Much more needs to be – and can be – done to make societies more resilient against such shocks. Governments, NGOs and private sector companies can work together to strengthen risk management and prevention in the most hazard-prone countries, and insurers and reinsurers can offer innovative risk transfer solutions that help governments secure funding before a disaster occurs.

The effects of disasters can be mitigated by having pre-event funding mechanisms in place...

While action to mitigate risk should be the first priority, there are still many events that cannot be prevented or where prevention may be prohibitively expensive. Where prevention is in theory possible, clearly no society can afford to prevent damage from each and every risk event, especially those that are the least likely to occur. The possibility of such events makes it necessary to devise emergency plans and secure finances for the recovery effort. A paradigm shift is required to move away from efforts to fund recovery plans for disasters after they occur to securing funds before the event has occurred. This can be achieved through (re)insurance and/or capital market-based solutions, which offer not only enhanced financial security, but also the possibility of rapid access to funds in the event of a catastrophe. Furthermore, they typically set incentives for risk mitigation.

...together with more systemic approaches to risk management, such as a Country Risk Officer.

In addition to new forms of disaster risk financing for sovereign governments, more systemic approaches to risk management can also help governments prepare for the perils they face. These approaches, such as that put forward by the Economics of Climate Adaptation Working Group, can enable countries and regions to manage the risks that they are confronted with and give them the basis they need to make more effective decisions about how to mitigate and adapt to the effects of risks such as climate change. Using risk transfer to spread residual risks to a broader community is an important part of this approach. A major piece of the puzzle would be to create the role of a Country Risk Officer who could oversee the various stages involved in integrative risk management and then coordinate efforts in the event of a catastrophe.

1. Country risk transfer

Losses from natural catastrophes are unpredictable and rising...

The rising impact of natural catastrophes is driving up the cost of disaster relief and reconstruction for the public sector, particularly in emerging and developing countries, where insurance penetration is low. Losses from natural disasters will increase further as economies continue to grow. The annual loss burden, however, will fluctuate significantly.

...but can be in part pre-funded through capital instruments.

Recent innovative transactions provide the public sector with new models to transfer risk to the insurance industry or to capital markets. Such forms of public-private partnerships in emerging markets can help make societies more resilient by funding disaster expenses more efficiently before – instead of after – a catastrophe occurs.

a) MultiCat Mexico

Mexico's vulnerability to natural catastrophes...

Mexico is a pioneer in transferring risk through public-private partnerships. Faced with natural perils in the form of storms over the Atlantic and the Pacific, as well as the risk of earthquakes, Mexico has been hit by at least six major events since 1985. In terms of loss of human life, the 1986 Mexico City earthquake which measured 8.1 on the Richter scale was worst, resulting in 9,500 fatalities. In economic terms, Hurricane Wilma which hit in October 2005 was the most devastating, causing total damage of USD 22 billion. Significantly, however, just USD 13.8 billion of that was insured.

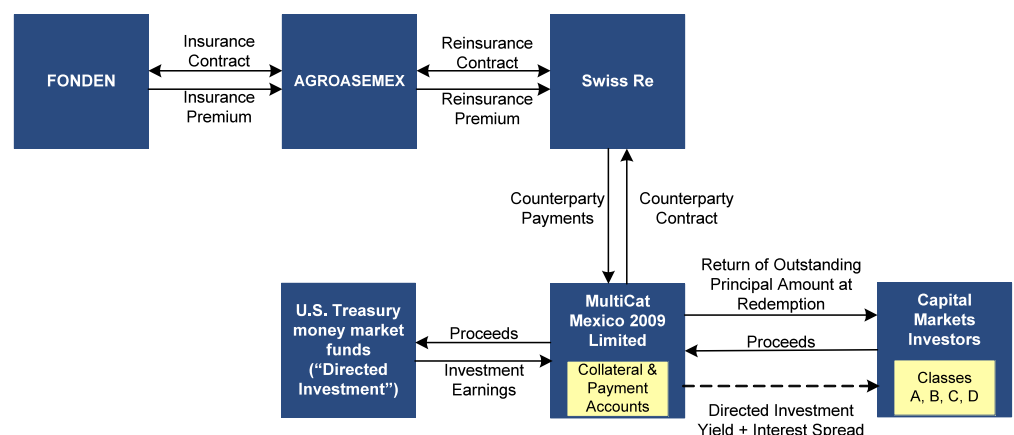
...prompted the authorities to create a catastrophe fund...

In an effort to improve financial preparedness for natural disasters, the Mexican government created FONDEN or the Fund for Natural Disasters in 1999. Managed by several government agencies including the Ministry of Finance and the Ministry of the Interior, the fund helps the general population in the event of natural catastrophes. With the intention of helping smooth the impact of payouts on the national budget, the Mexican government wanted to arrange a risk transfer transaction that would cover USD 290 million of earthquake and hurricane risk. The Mexican government, through FONDEN, appointed AGROASEMEX (the Federal Government's insurance company) to act as the insurer for the transaction.

...which in turn sought insurance coverage to smooth cat fund payments.

The result was MultiCat Mexico 2009, the first transaction in the MultiCat Program, a shelf programme arranged by the International Bank for Reconstruction and Development (part of the World Bank) in collaboration with Swiss Re Capital Markets, to provide a cat bond issuance platform for member countries to access natural disaster protection from the capital markets. Swiss Re acted as co-lead manager and joint bookrunner for this particular transaction, drawing on its experience in expanding capacity for public sector entities in emerging economies: Swiss Re already conducted cat bond transactions for Taiwan in 2003 (Formosa Re) and for Mexico in 2006 (CAT-Mex). The following graphic demonstrates the relationships between the various parties in the transaction (see Figure 1).

Figure 1:
MultiCat Mexico 2009 –
Illustrative transaction structure



Source: Swiss Re

The insurance product is structured on a parametric basis...

Like many cat bonds, the Mexican transaction is based on a parametric approach: unlike traditional insurance, parametric instruments use a model to calculate the payout of the insurance policy. This payout model aims to closely mirror the actual damage on the ground and enables a much more rapid payment as no assessment of the actual damage is required after the event. In the case of parametric insurance, the payout is triggered by a measure such as the strength of an earthquake on the Richter scale or the air pressure experienced during a hurricane. Unlike traditional insurance, parametric insurance does not require loss adjusters to tally damage after a catastrophe occurs, a process that can take months or even years and which can delay a payout. The speed of payout is one of the significant advantages of this type of transaction: a parametric trigger is transparent, both for the insured and for investors, and it means that loss events can be handled faster and more efficiently than with other kinds of insurance-based solutions.

...offering multi (named) peril coverages.

In the MultiCat Mexico 2009 transaction, there are four tranches each relating to a different peril: USD 140 million to cover earthquakes and USD 50 million each to cover hurricanes in two Pacific coastal regions and one Atlantic region. Each tranche therefore has a different trigger: for the earthquake cover, for instance, three seismic zones were identified covering the Northwest Cocos, Central Cocos and Mexico City regions, with magnitude and depth measures determined for each. For the hurricane covers, the payout is triggered if a storm passes through one of the coastal zones and the pressure at the centre of the storm is the same as or below a set level (944 mb or lower for the Pacific coastal regions and 920 mb or lower for the Atlantic coastal regions).

b) Caribbean Catastrophe Risk Insurance Facility (CCRIF)

Country risk coverage is also offered on a regional basis...

The CCRIF is another example of a risk transfer scheme designed to provide 16 Caribbean governments with immediate relief in the form of short-term liquidity in the event of hurricanes and earthquakes. Established in 2007 on behalf of the Caribbean community under the guidance of the World Bank, the CCRIF was the world's first regional insurance fund and offers insurance coverage for governments in the region. By focusing on putting contingent funding in place before catastrophes occur, this program represented a real shift in the way that governments treated risks and the economic costs associated with them. In June 2007, at the start of the Atlantic Hurricane Season, the CCRIF was launched.

Like the MultiCat transaction, the CCRIF is based on a parametric trigger. United States Geological Survey (USGS) earthquake location data is used as input to models which estimate the losses due to an earthquake. For hurricanes, National Oceanic and Atmospheric Administration (NOAA) wind speed data is used as the input to the hurricane model in order to estimate loss. It is the estimated loss, calculated objectively, which dictates whether or not a policy triggers and how much the payout will be.

...the first payments from which have already been made...

The CCRIF made two payouts in its first year, both as a result of the magnitude 7.4 earthquake which shook the eastern Caribbean on November 29, 2007. The St. Lucian government received USD 0.4 million while the Dominican government received USD 0.5 million. The sums of money went towards post-earthquake recovery efforts in both these nations.

...including to Haiti in the wake of the 2010 earthquake.

In January 2010, a Mw 7.0 earthquake occurred in Haiti causing significant damage and loss of life. The parametric earthquake insurance policy paid its full limit of USD 8 million, providing the nation rapid access to insurance proceeds after the quake. Against the loss of life experienced as a result of the earthquake, the USD 8 million payout was not a major sum of money. However, this is not the point. The point is that the Haitian catastrophe has highlighted the potential of parametric insurance to help countries plan for and pre-finance natural disasters as part of a comprehensive disaster risk management strategy.

c) Malawi drought risk cover

Weather derivatives can be established in largely agricultural economies...

The market for private sector weather derivatives has been growing strongly for over 10 years and the insurance industry has now successfully translated this tool to the public sector in order to help small farmers in countries such as Malawi to weather the extreme climate. These insurance products are tied to an index such as rainfall, temperature, humidity, crop yields, or satellite-based vegetation images rather than to actual losses. As a result, administrative costs for these products are much lower, as there is no need for a case-by-case damage assessment.

...which can be particularly vulnerable to drought...

Since a country like Malawi is heavily dependent on agriculture, any shortfall in crop production as a result of drought is a significant issue both for farmers and society at large. Malawi worked together with the International Development Association (IDA), the arm of the World Bank that helps the world's poorest countries, to create a weather derivative contract that pays out up to USD 5 million to the government of Malawi to support its maize farmers in the event of a shortfall in crop production when rains fail. Swiss Re acts as the counterparty of IDA and absorbs the drought risk.

...and are administered on a parametric basis.

The derivative links rainfall and maize production such that if precipitation over a certain period of time falls below a certain level, then the model will calculate the projected loss in maize production. The maximum payout is reached if maize production drops to 10 percent below the historical average. This solution is a prime example of ways in which a pre-emptive approach to disaster risk management can help governments and individuals prepare for devastating events by providing them with an affordable way of hedging against weather risks.

d) Beijing agriculture transaction

Public-private agricultural partnerships can be undertaken in more developed economies...

Swiss Re is working with the Beijing Municipal Government to provide reinsurance coverage for catastrophe risks under China's government-funded agricultural insurance scheme. Supported by the China Insurance Regulatory Commission (CIRC), this public-private partnership facilitates the sustainable development of agricultural insurance, stimulating agricultural productivity in China.

... with reinsurance coverage pooled together with subsidised insurance...

Under the agreement, the Beijing Municipal Government will pool all agricultural insurance business within Beijing, and provide funding for purchasing reinsurance cover for this business directly from the reinsurers. The beneficiaries will be the insurance companies under the government-subsidised agricultural insurance scheme in Beijing. In the event of catastrophe loss, Swiss Re, as the lead reinsurer, settles with individual insurance companies, ensuring that each has the appropriate reinsurance protection.

...and losses absorbed in layers between different parties.

Based on the agreement, the insurance companies will be responsible for losses below 160% of the annual premium. Swiss Re and another reinsurer will take up the losses between 160% and 300%, while the losses above 300% will be covered by the Beijing Municipal Government's Agricultural Catastrophe Risks Reserve.

This agreement provides tailor-made reinsurance protection for livestock, crops and fruits against perils such as epidemics, livestock diseases, flood, hail, wind and rainstorms. It covers about 400,000 farming households.

e) Other risks

Potential for other capital risk market transfer exists, such as longevity.

Natural catastrophes are not the only risks that governments need to take into account when it comes to the consideration of the budget impact of disasters: continually rising life expectancies make longevity risk one of the biggest issues facing society, particularly with regard to public and private sector pensions. Demand from pension funds and life insurers for reinsurance solutions that help them transfer these risks is growing along with risk awareness.

2. The cost of catastrophes as a driver for better risk management

Although there is considerable annual variation in global catastrophe losses...

Each year brings new disasters and new tragedies: in 2009, earthquakes rocked Indonesia and Italy, claiming scores of lives and leaving thousands displaced or homeless, while typhoons swept across Cambodia, Vietnam and the Philippines, bringing devastation, significant flooding and a considerable clean-up bill. Australia was ravaged by fierce bushfires while parts of Africa were afflicted by drought. While not as disastrous a year in terms of natural catastrophes as 2008, last year was still relatively costly: according to initial estimates, the total cost to society of natural catastrophes and man-made disasters in 2009 was USD 52 billion versus USD 267 billion in 2008. The cost to insurers in 2009 was USD 24 billion. Insured losses were below average due to a calm US hurricane season.

a) Trend towards higher natural catastrophe losses evident...

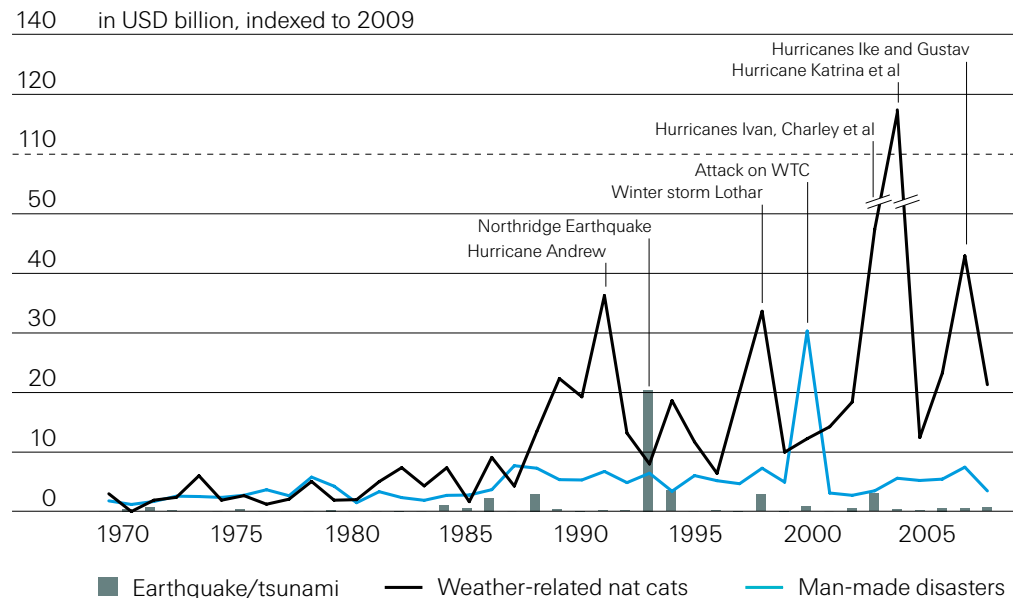
...the underlying loss trend is climbing..

Since the 1970s there has been a clear increase in the cost of natural catastrophes: worldwide average insured natural catastrophe losses between 1970 and 1989 were USD 5.1 billion per year, rising to more than USD 27 billion annually between 1990 and 2009 (see Figure 2). Events such as Hurricane Katrina in 2005 pushed the annual cost of catastrophes to over USD 100 billion.

...with climate change being an observable trend.

The impact of climate change is one of the factors driving this increase: as global temperatures change, severe storms and floods are likely to become more frequent. Winter storms and wind-related losses in Europe are set to rise sharply and tropical cyclones in North America could also increase in intensity. Risks from storm surges and rising sea levels, which could reach one-and-a-half metres by the end of the century, will also increase as a result of climate change. However, climate is not the only factor: the increase in economic value around the world in the years since 1970 has led to an increase in the cost of natural catastrophes, as has the concentration of economic value in certain regions of the world that are prone to earthquakes or hurricanes, such as, for example, the south-eastern coastline of the United States.

Figure 2:
Insured catastrophe losses
1970–2008



Source: Swiss Re Economic Research & Consulting

b) ...but significant under-insurance remains

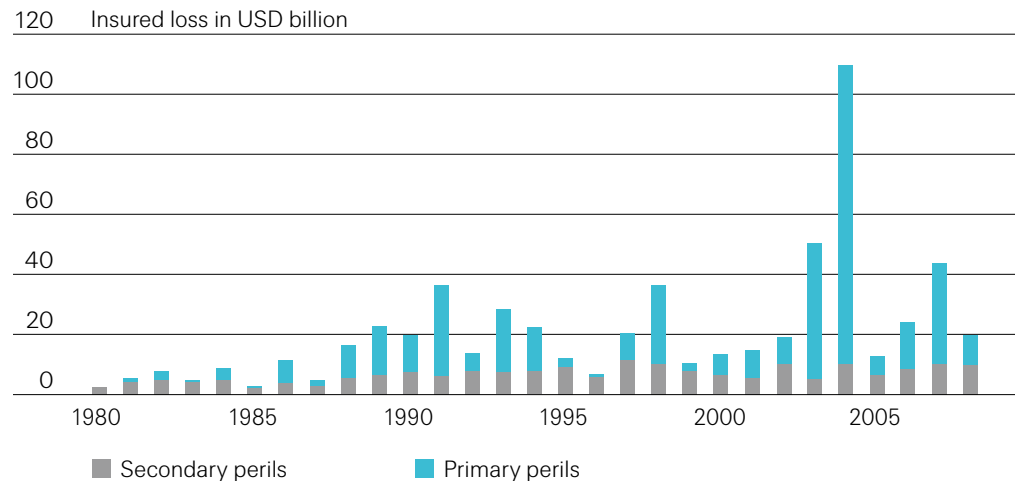
Natural catastrophes costs are harder to absorb for countries with low insurance penetration...

Nations with low insurance penetration are the least able to absorb the unexpected and unbudgeted costs of natural disasters. These tend to be those countries that are still emerging economically. These uninsured losses often fall to governments, corporations and individuals to pay, leading to higher levels of government or personal indebtedness and the depletion of assets. The impact of these uninsured losses is not just felt in the aftermath of the disaster either: they can have repercussions many years down the line. In order to make up for the costs, governments might be forced to raise taxes, leading to an increased burden on individuals and potentially a knock-on effect on the economy. Alternatively, governments may choose to postpone or defer planned investments, including investments into those very projects which might in future mitigate the kinds of disasters that cause the problem in the first place.

...as can be seen by the example of China.

By way of illustration, China, although it is a strongly growing economy, has a comparatively low level of insurance penetration of between 1 and 2 percent for life and non-life insurance. Looking at the proportion of insured to uninsured losses in 2008 shows the impact of this low penetration (see Figure 3): in that year an earthquake struck in the Sichuan Province of China, claiming over 80,000 lives and leading to losses of USD 124 billion. Insured losses, on the other hand, were just USD 0.75 billion. Given the sheer size of the Chinese economy and the government budget, the government was able to absorb the costs.

Figure 3:
Natural catastrophe losses
1980–2008, in USD billion



Source: Swiss Re Economic Research & Consulting

c) *Public-private partnerships*

Governments can play an important role in spreading insurance and risk resilience...

Promoting insurance is an important step towards making societies more resilient: private individuals and corporations should be encouraged to ensure that they have appropriate cover. Governments are uniquely positioned to create the conditions that support the kinds of measures that can make a country more resilient: they can pass laws or lay down rules governing the design and construction of infrastructure; they can set out the procedural responses to disasters or they can influence the behavioural responses to disasters. However, the challenge of disaster financing remains.

...with public-private risk solutions one effective means of doing so.

The private sector, and specifically insurers and reinsurers, are not in a position to create the frameworks that promote prevention and mitigation, but they do have the financial means and the capacity to absorb some of the risks that governments face. Furthermore, those risks that cannot be held by individual companies or by a pool of companies can be transferred to the capital markets. By putting a price tag on risks, insurers provide incentives for risk mitigation measures. In collaboration, private and public sector players can achieve both an effective reduction in the impact of catastrophic risks and in the financing of the material and economic losses they can cause.

d) A framework for managing climate risk

In addition to partnerships that encourage the sharing of the risk burden, important work is being done in designing new frameworks to help countries or regions manage their risks more actively.

Economic losses from climate change could be considerable...

The Economics of Climate Adaptation Working Group¹ conducted eight on-the-ground test cases around the world to determine the impact of changing climate on regional economic conditions. The Group found that climate change could cause significant incremental losses, over the next 20 years, given continued economic growth and the susceptibility of some societies to today's climate. Significant economic value is at risk: if current development trends continue, then the locations studied stand to lose between 1 and 12 percent of GDP by 2030 as a result of natural catastrophes.

...requiring official mitigation strategies...

Decision-makers in vulnerable societies face a series of questions when they come to consider how to prepare for this change in climate. These questions include: What is the potential loss that our societies face in the coming years due to climate change? How much of that loss are we able to avert and how? How much do we need to invest in order to fund these measures? And, will the benefits of this investment outweigh the costs?

...created using risk management frameworks and analysis...

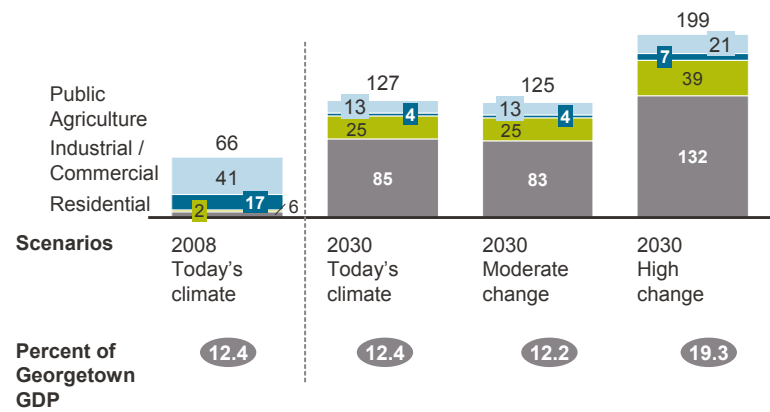
To answer these questions, the working group created a decision-making framework, based around two sets of tools. First, the framework provides tools to assess and quantify the "total climate risk" of a particular area, taking into account today's climate risk, future economic development, and the potential incremental losses that could occur over a twenty-year period if the climate changes in the way that science currently suggests. The second set of tools uses a cost-benefit analysis to evaluate the various potential measures available for adaptation, such as infrastructural, technological, behavioural and financial solutions. The output of this step creates a useful input for a country to consider, alongside policy, capacity and other considerations, when it comes to making decisions about adaptation.

...undertaken at a sufficiently granular local level.

To explain this in further detail, while a great deal of attention is focused on the incremental impact of climate change around the world, there is still much uncertainty around what rising temperatures mean locally. The Economics of Climate Adaptation Working Group suggests therefore that decision-makers focus on the total losses they are likely to face locally under various climate change scenarios and then use this figure to decide how to avert them with the most appropriate adaptation measures. For each of the eight locations studied, the Group created three different scenarios of what the climate will be like in 2030, one assuming that nothing changes, one taking the moderate end of forecasters' predictions and one a high-end prediction. From these scenarios, the Group was able to determine a figure in dollars of expected losses (by way of illustration, see the example of Guyana in Figure 4).

¹ The Working Group was formed by Global Environment Facility, European Commission, the Rockefeller Foundation, Climate Works, Swiss Re, McKinsey, Standard Chartered Bank. Swiss Re was lead contributor to the research, defined the assessment and risk modeling approach and provided overall risk assessment knowledge

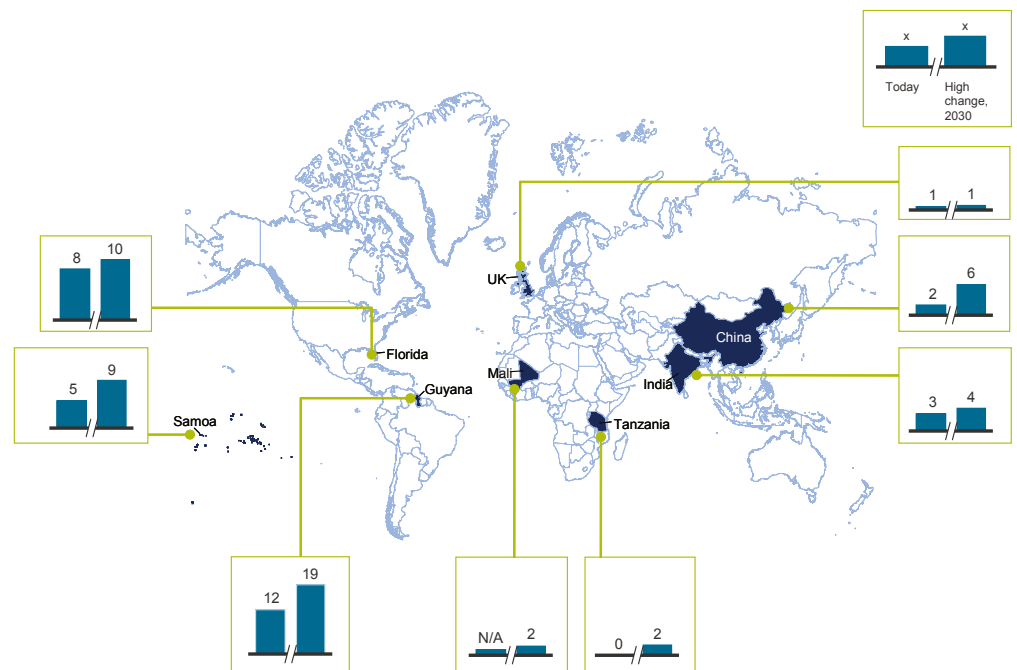
Figure 4:
Annual expected losses
in 2008 (in dollars)
and 2030 (in USD m)



Source: Economics of Climate Adaptation Working Group

In order to get a clear sense of the magnitude of these losses for the various countries and regions in question, the Group then expressed them as a percentage of gross domestic product (GDP). The losses range from one percent of GDP in the low scenario to a maximum of 19 percent in the high scenario, illustrating the vulnerability of certain locations when compared with others (see Figure 5).

Figure 5:
GDP impact of expected
losses

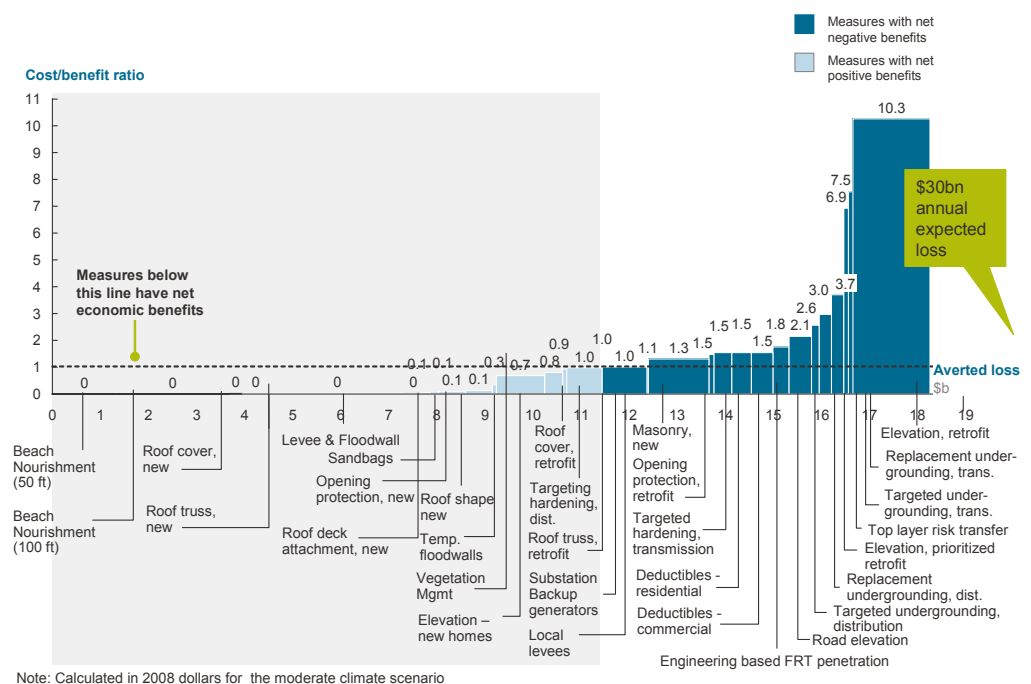


Based upon select regions analyzed within the countries (e.g., Mopti, Mali; Georgetown, Guyana Hull, UK; North and Northeast China; Maharashtra, India; Central regions of Tanzania; Southeast Florida, U.S.)

Source: Economics of Climate Adaptation Working Group

To gain a full picture policy makers must understand the cost of mitigation...

Figure 6:
Cost/benefit curve of measures to mitigate against climate change Florida, USA



Source: Economics of Climate Adaptation Working Group

...balancing the costs of risk transfer with the costs of risk prevention....

The residual losses can be dealt with the kinds of risk transfer solutions that the insurance and reinsurance industry offers. Risk transfer can cap losses and smoothe the cost of climate events to individuals, corporations and governments. It can also help protect livelihoods from catastrophic events and increase the willingness of decision-makers to invest in economic development. While prevention measures can go some way towards reducing potential losses, risk transfer can significantly reduce the cost of prevention and mitigation overall by bearing the risk of the rarer or more extreme events. For instance, it rarely makes economic sense to design a building that can withstand the most extreme wind. But it does make sense to build for severe wind and then to transfer the risk of the more extreme events to capital markets through insurance companies. In this context, the case of Samoa is a particularly relevant one: here in this island state the cost-benefit analysis showed that risk transfer proved to be the more economic means of tackling residual storm risk, with physical measures being significantly more costly.

...to improve society's resilience at an appropriate administrative cost.

Risk transfer already makes a major contribution to the developed world's relative climate resilience but there are still many opportunities for risk transfer to play a much greater role in protecting against climate risk in the emerging world. In particular, index-based insurance solutions as discussed earlier in this article could be particularly attractive, given the relatively low administrative costs and the fast payouts for those affected.

3. Towards integrative Country Risk Management

As the recent financial crisis has shown, the risks that a country faces are increasingly broad and increasingly interconnected. As a result, there is a higher level of systemic risk than ever before. Managing this risk landscape requires a systematic and integrated approach.

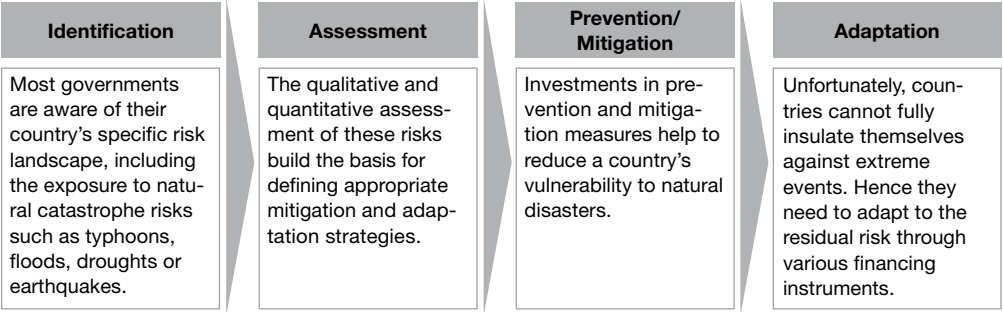
Systemic risk management is required to employ optimal solutions...

While most governments are aware of their most prevalent exposures, only very few governments apply a systematic risk management process. One consequence of this is that most losses are still financed after an event. This should change. The key questions that a country faces when it considers risks from an integrative perspective are as follows: Where should the state deploy its financial resources to protect people and assets? Where is it worth preventing a loss, where should we reduce the impact and where is it better to secure finances in case it happens? What is the optimal mix of these options? Then the question arises, who is managing risk in such a way at government level? The concepts of integrative risk management, risk maps and a Country Risk Manager go some way to answering these questions.

...a process that can be understood in four steps.

As a rule, integrative risk management involves four stages (see Figure 7). The first involves identifying risks and potential risk scenarios across all categories at an early stage in their development and then creating awareness. Secondly, risks are assessed and quantified according to the likelihood of their occurrence, the severity of their impact should they occur and their interrelation to other risks. The third stage is one of risk mitigation, including the reduction or avoidance of risk by means, for example, of construction measures or legal requirements. Finally, there needs to be adaptation to risk, including measures to finance economic losses, such as risk transfer mechanisms.

Figure 7:
The four stages of integrative risk management

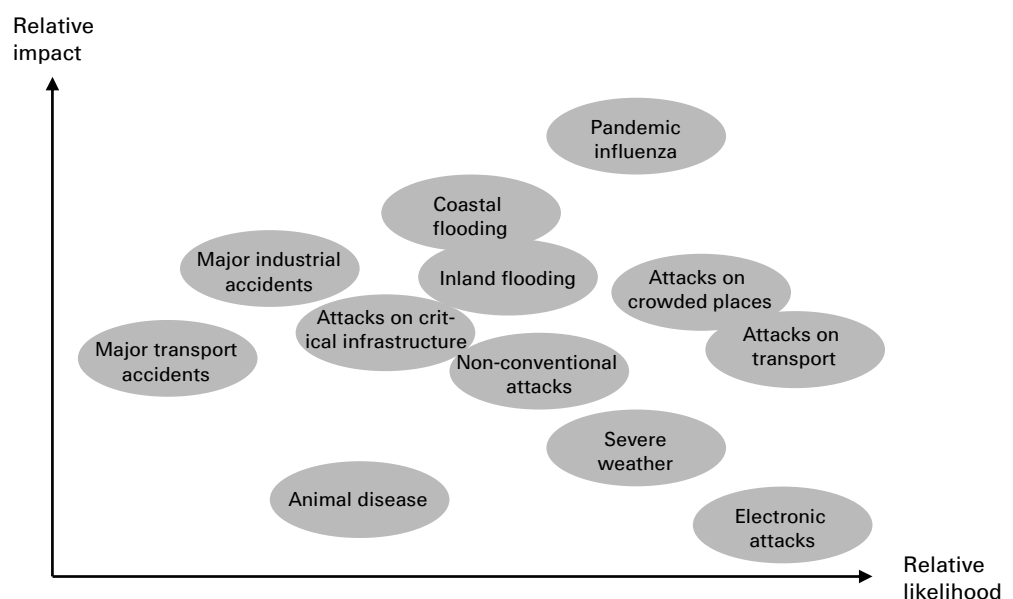


Source: Swiss Re

From this process risk maps
can be produced...

Risk maps, which plot the various threats that a country faces on the axes of frequency and severity, can create a view of total risk and provide a government with the basis on which to prioritise risk mitigation measures. They are a useful basis for discussion as to which risks are deemed acceptable to a society and where resources should be focused. In terms of assessing and quantifying risks, the United Kingdom is considered a pioneer. In 2008, the UK published its first National Risk Register, incorporating a risk map which gives an overview of potential risks and the extent of the losses associated with them (see Figure 8). The government has also created a detailed list of all the loss events that may be large enough to warrant state intervention and has provided advice to organisations and private individuals on how they can prepare themselves for a loss event.²

Figure 8:
UK National Risk Register



Source: UK Cabinet Office

...to help structure responses at
the most suitable administrative
level...

Considering all these risks requires a high degree of coordination between the various levels of government and administration, private-sector operators and the insurance industry. It would seem that a central figure – a country risk officer or minister – could usefully head up such efforts and serve as a point of contact for the various stages of the integrative risk management process. Not only would this function ensure that risk assessment and detection measures are coordinated, but it would also ensure that the responsibility for mitigation measures is correctly delegated and implementation supervised. The country risk officer might also be the primary coordinator of adaptation measures, overseeing, for example, a complex climate adaptation study such as the one described earlier or acting as the chief negotiator for the kinds of risk transfer solutions that the private sector can offer (see Figure 9).

² OECD, Innovations in Country Risk Management, 2009

Figure 9:

The role of a Country Risk Officer

Objective

Optimal allocation of resources for systematic risk identification, assessment, mitigation and adaptation.

Tasks

- work jointly with (re)insurance industry to identify emerging risks
- establish frequency/severity risk landscape based on best scientific knowledge
- communicate risk landscape to policy makers and general public
- steer mitigation efforts towards biggest risks (either frequency or severity)
- manage a pool for mega risks which cannot be carried by (re)insurance industry alone

Benefits

- active private/public partnership including knowledge exchange
- much more risk knowledge at policy maker level and general public on key risks
- more rational mitigation strategies and usage of public funds
- less human, physical and economic damage
- higher economic growth since uncertainties about mega risks removed (eg terrorism)

...which could be presided
over by a country risk officer.

A country risk officer would essentially act as a central point of contact for the purpose of managing a multi-area risk portfolio. The country risk officer can take on this role, make use of synergies and avoid duplication within government offices by ensuring that the emergency plans for a variety of catastrophe situations can be implemented and that the various departments are not all independently devising their own. He or she could also handle the international coordination of cross-border risks.

4. Conclusions

Societies are becoming more vulnerable as the risks they face become more interconnected. Integrated risk management approaches are needed to recognise risk interdependencies, set priorities and take decisive action to prevent, reduce and transfer risks.

Such an all-hazard approach demands a high level of coordination across government, political and private sector bodies. A country risk officer could be responsible for managing such a prioritised risk landscape, taking an holistic approach to risks before events occur and ultimately reducing the risk burden to society.

Risk avoidance and mitigation strategies must be the first priority in managing natural disasters, in order to reduce the extent of any loss and thus also the required funding. However, no organisation or country can fully insulate itself against all extreme events. Innovative risk transfer solutions help governments secure funding before a disaster occurs

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Chapter 3: Lessons learnt from climate risk



Changes in climate will increase risk vulnerability disproportionately for certain parts of the world.



Managing Africa's natural disaster risk

Joanna Syroka, Richard Wilcox – Mobilisation of resources to finance the delivery of emergency food assistance and other relief usually occurs after a disaster has already struck. However, using modern risk analysis and mapping technologies, it is possible to better anticipate and plan financially for weather disasters and their effects on food production and vulnerable populations. Moreover, better information would allow a pooling of risk exposures among countries with a higher exposure to extreme weather events. Such risk pooling would allow for the application of principles from and financing solutions with the global risk transfer industry. With climate change likely to exacerbate extreme weather conditions for those most vulnerable, enhanced risk management and transfer will allow for enhanced disaster relief and impact mitigation.

Weather risk and poverty

Current disaster relief for increasingly vulnerable countries is largely ex post.

The livelihoods of the world's most vulnerable populations are closely linked to variations in weather patterns. Climate change and the increased potential for natural disasters will affect them more adversely than others. As currently structured, the international system for responding to natural disasters is not as timely or equitable as it should be. Funding is secured on a largely ad-hoc basis after disasters strike and only then can relief be mobilised towards the people who need it most. In the meantime, lives are lost, assets are depleted and development gains experience significant setbacks – forcing more people into chronic destitution in the world's least developed countries. Challenged by both increased climate risks and higher commodity prices, in addition to other setbacks vulnerable populations may face – as a result of the global economic slowdown, health risks or conflict, for example – the traditional disaster response system, even in the mid-term, may no longer be able to cope with the financial magnitude of the assistance required. The system will be pushed into being restructured. A transformation towards a disaster risk management system is necessary, urgent and possible.

Disaster relief for vulnerable communities is better managed through contingency funds...

A disaster risk management system would seek to allocate certain resources against probable but uncertain risks. Most weather events, such as droughts or floods, although uncertain in terms of their exact timing and magnitude in any given year or season, are predictable – they have happened before and are likely to happen again. Contingency funding allows systems to be built to respond to weather shocks more efficiently, protecting lives and livelihoods and mitigating the humanitarian and developmental impact of risk through timely and appropriate responses. The principle across all possible contingency funding instruments is to shift, to the greatest degree possible, known risks away from vulnerable populations to institutions better positioned to manage these financial risks.¹ This type of funding against known risks is more effective as a financial base for disaster assistance as it is timely (available when the disaster strikes instead of when subsequently mobilised) and reliable (already dedicated a priori, not subject to competing claims).

¹ Our 2006 article “*Rethinking International Disaster Aid Finance*” spells out this argument in full: Syroka, J., and R. Wilcox, 2006: Rethinking International Disaster Aid Finance. *Journal of International Affairs*, “The Globalization of Disaster”, Volume 59, 2, Spring/Summer 2006.

...which allow greater cost transparency and enhanced disaster preparedness efforts...

The certainty of contingency funding creates incentives for contingency planning to allow more effective operational responses; the cost of contingency funding creates incentives for disaster risk reduction. The expense of contingency funding – whether retained by individuals, governments or donors in the opportunity costs of funds set aside or transferred in return for premium payments – renders visible the true potential costs of known risks. Thus, these stakeholders can make meaningful decisions about how these costs will be shared among them. As risks are translated into potential expenditures and then aggregated, the “portfolio effect” of pooling diverse risks can significantly reduce overall risk management costs – and in some cases halve the cost in comparison to the sum of what might be needed if each country individually set aside contingent funds. Known risks in the present disaster aid system also carry costs but these are not immediately apparent. The risks are inadvertently retained by the weakest link in the chain, the vulnerable populations themselves, and only become visible as even greater levels of poverty develop post disaster.

...and improved proactive risk responsiveness.

Incentives for restructuring the disaster aid system are not only economic. The present system relies on advertising misery and destitution at their peak in the wake of disaster. An efficient risk management system, to the extent possible, anticipates risks and seeks to protect productive but vulnerable populations against these risks. In so doing, a restructured global disaster management system importantly protects basic human dignity.

Improving the disaster response system

The UN WFP encourages a shift from disaster relief to managing disaster risk.

As the organisation responsible for three-quarters of emergency food assistance, the United Nations World Food Programme (WFP) can act as a catalyst for any significant transition in the world’s disaster response system. Two-thirds of all emergency food assistance is delivered to Africa and approximately half of WFP’s expenditures are a result of weather-related causes. WFP’s central role in the international disaster aid community; its global field presence and credibility in developing countries most at risk; its pioneering role in disaster risk finance combined with its leadership’s commitment to maximising the organisation’s value to vulnerable populations uniquely positions WFP to help channel the disaster aid system’s transformation towards one that creates greater value for vulnerable populations by managing disaster risks instead of merely responding to disasters as they occur. As the developing world’s “provider of last resort”, no other organization has such a large portfolio of risk on behalf of vulnerable populations.

Managing disaster risk begins with understanding that risk...

However, to be able to improve the system in any way, be it through improved financing of emergency responses, better emergency preparedness and contingency planning or even investments in risk mitigation, developing countries, WFP and the greater disaster assistance community have to first understand the risks they hold on behalf of the world’s most vulnerable populations. For example, current answers to key questions, such as, “how many people does WFP expect to assist next year due to weather related events?” and, “approximately how much will this assistance cost?” – information needed to globally and systematically begin a transition to a more proactive system for emergency response – are difficult to answer. The current reactive emergency aid business model has not required this kind of thinking.

...through programmes
such as the WFP's Climate and
Disaster Risk Solutions.

Funded by the Rockefeller Foundation and hosted at WFP, Climate and Disaster Risk Solutions aims to quantify the disaster assistance community's weather-related food security risk in operational cost terms. The aim of Climate and Disaster Risk Solutions is to model and analyse the potential financing requirements of weather-related food security disasters and, thereby, lay the quantitative and strategic groundwork for transition to an improved means of financing the international disaster response system.

Quantifying a portfolio of risk

Weather reports are combined with
other spatial data series...

The basic data components required to quantify weather-related food security risk are information about the weather (hazard), information about current vulnerability of food insecure populations (vulnerability) and information about today's response costs (exposure).

Weather data alone is not enough. This data must be converted into meaningful indicators for food security. In order to understand the impact of droughts or flooding on crops and how these may impact food availability for a local population, for example, means we need not only rainfall data, but information on potential evapotranspiration, soil types and water holding capacities, what staple crops are grown where and their cropping calendars, among other information, in order for rainfall data to be converted into something meaningful for crop production. For floods, again we need to understand elevation, land cover, water basin and catchment area boundaries to understand when too much rainfall could lead to flooding events that disrupt lives and livelihoods. A similar process is required for cyclones. It is this aggregation of different types of data that converts real-time weather information into meaningful maps that describe the timing, spatial extent and magnitude of a drought, flood, cyclone or other adverse weather event.

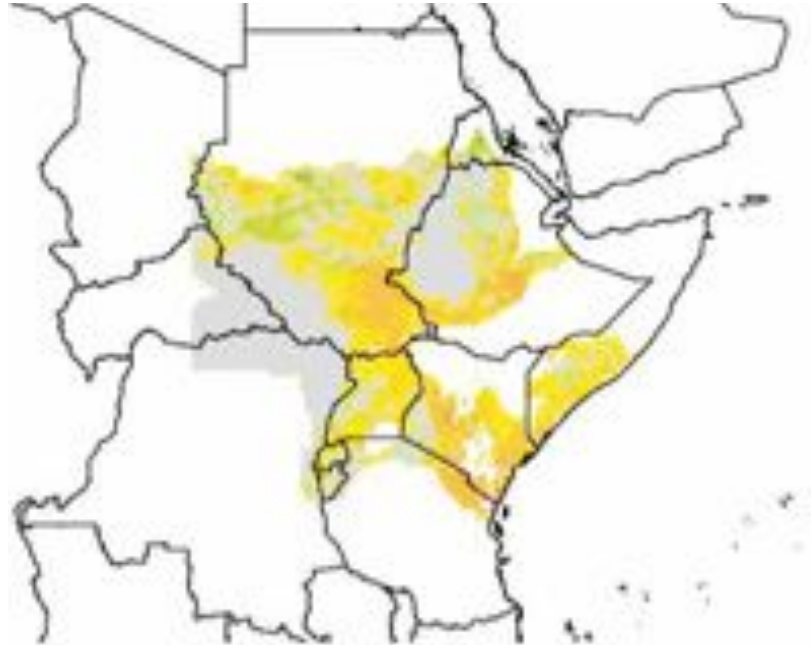
...to provide a detailed map
of the potential vulnerability of
a particular area...

In order to systematically estimate the extent and nature of the overall weather risk of vulnerable populations in all countries, this information is needed globally to generate consistent high-resolution information on drought, flood and cyclone risk. Furthermore, a sufficiently long history of adverse weather events is needed to assess and quantify these risks, as well as real-time updates so that the risks can be monitored as they evolve. Fortunately, today's cutting-edge remote-sensing, mapping and computing technology provides the information and infrastructure needed to construct this portfolio at the national and continent-wide levels required for enhanced risk management.²

Figure 1: A map of East Africa's 2009 long rain season (April–October) showing the “compare to normal” feature for Africa RiskView's agriculture drought indicator, in this case the FAO's Water Requirement satisfaction Index (WRSI) for maize, a food staple in the region. Areas where the 2009 WRSI is below the long-term average are coloured in yellow, orange and red, areas where the WRSI is near the average are coloured in grey and above average areas, where the WRSI for 2009 is greater than average, in green. It is clear the 2009 rainfall season was significantly below average in terms of rainfall timing, amount and distribution for maize and by extension other rain-fed staple crop production in many parts of the region, including Ethiopia, southern Sudan, parts of Uganda and Kenya. Emergency drought appeals were launched by all countries in response.

² The US National Oceanic and Atmospheric Administration's (NOAA) Climate Prediction Centre produces ongoing rainfall estimates (RFE) using satellite and station data at a 0.1 x 0.1 deg latitude by longitude resolution for Africa. Datasets are currently available from 1995, however there are plans to reprocess the Africa Rainfall Estimate Climatology (ARC) dataset back to 1983: <http://www.cpc.noaa.gov/products/fews/rfe.html>

Figure 1:
Screenshot of East Africa's
2009 long rain reason
(April–October)



...overlaid with figures on
 population density...

However, simply understanding the weather is not enough. We need to know where people live, what they do and if and why they are vulnerable to the weather shocks we observe. For this, we have to rely on WFP's and partner organization surveys, analyses and data to construct the food security profile of populations at risk. This means understanding the status of food availability, access and utilization for a given population, what it would take to make them food insecure and what the appropriate assistance and response should be. WFP houses the world's most detailed repository of historical food assistance operations data, in addition to numerous household surveys and population studies that help to answer these questions. In 2007 the organization's Vulnerability Assessment & Mapping (VAM) Unit received a grant from the Bill and Melinda Gates Foundation to conduct Comprehensive Food Security Vulnerability Analyses (CFSVA) for many countries where WFP has an operational presence. Through the CFSVA process, WFP is refining its vulnerability metrics for specific countries and environments to determine more accurately who is at risk, why they are vulnerable, how many people there are and where they live³.

...which can be converted
 into cost estimates...

Global datasets on population densities⁴ and administrative units help to aggregate this household-level data to geographic levels meaningful for an external operational response. Finally, once we understand how to convert information on the extent and magnitude of a weather shock into the number and degree of people in need, we need to convert that into operational costs. Historical records on WFP operational expenditures and information about current commitments and costs provide a good estimate of external operational costs in today's dollar terms for possible weather-related emergencies.

³ For more information about VAM's CFSVA initiative visit <http://vam.wfp.org/cfsva>

⁴ eg the Oak Ridge National Laboratory (ORNL) LandScan dataset, <http://www.ornl.gov/sci/landscan/>

...bringing together what had previously been largely separate processes.

The process outlined above combines three well-established but distinct disciplines – crop monitoring and early warning, vulnerability assessment and mapping, and humanitarian operational response – to enable the application of a fourth, financial risk management. The objective is to bring these disciplines – fields of study that do not often interact – together in a potentially powerful way. By leveraging the proven technologies of each discipline, information available can be integrated in each step of the process to provide meaningful and consistent information on weather-related food security risk for decisions makers and fund managers. With this view, Climate and Disaster Risk Solutions is developing a standard-setting methodology for how multiple sets of data and fields of study can interact to manage weather-related food security risk at the national, regional and continental levels.

This technique is being applied to every African country...

For example, for each African country the aim is to combine knowledge of past weather events and the resulting needs with information on current population vulnerability and today's operational costs to estimate the average cost and the probable maximum cost (the largest cost that is expected to occur in 100 years) of weather-related events that can occur in the coming season.⁵ After taking into account disaster risk management tools at the disposal of a country such as strategic grain or cash reserves, safety nets⁶, contingent funds provided by donors or insurance products, one can determine what gap the aid community may be called upon to fill and then translate this into current operational costs.

...to create a systematic mapping data set for the continent.

The process above describes the first product of the Climate and Disaster Risk Solutions initiative, the Africa Synthetic Risk Model (ASR), a standard methodology for assessing the impact of droughts⁷ of varying severity by translating satellite-based rainfall information into needs estimates. These potential numbers of people affected correlate at nearly 90% to actual drought-related WFP responses and beneficiaries in Africa over the past decade. Repeating this analysis for every country is a significant task. In order to organize, manipulate and interpret these multiple datasets, the core technical work of the Climate and Disaster Risk Solutions is to develop an operational solution that aims to translate real-time and historical weather data into current and potential food security needs. Building from the ASR, a second product, Africa RiskView, is a software platform that absorbs, prioritizes and interprets different types of weather data and remote sensing products, such as rainfall estimates, vegetation data as well as more static spatial information on crops, soils and populations. Africa RiskView will be a central product of this new endeavour, translating weather information into figures that are useful for decision makers.⁸

⁵ Estimates of the potential operational costs from events that occur at all frequencies, ie every 10 years, every twenty years, every fifty years etc.) will also be important in order to aid decision-makers in interpreting the magnitude of what may be needed and to contextualize the probable maximum cost.

⁶ Productive safety nets, such as Ethiopia's Productive Safety Net Programme (PSNP), which focuses on asset building and protection for the country's chronically food insecure and poorest, have made some head-way in securing predictable, multi-annual resources for recurring, annual events. However the longer-term sustainability of these investments is dependent on preventing the transiently food insecure segment of the population – those currently outside the PSNP system – becoming needy beneficiaries of the programme following a disaster shock. This in turn depends on predictable, timely and sufficient additional financing for the emergency response they may need in a crisis year, in addition to the increased needs of those within the PSNP. For more information refer to the World Bank presentation "The Productive Safety Net Programme in Ethiopia", <http://info.worldbank.org/etools/docs/library/207058/The%20Productive%20Safety%20Net%20Programme%20in%20Ethiopia.pdf> and Hess, U., W. Wiseman and T. Robertson, "Ethiopia: Integrated Risk Financing to Protect Livelihoods and Foster Development", Discussion Paper, November 2006.

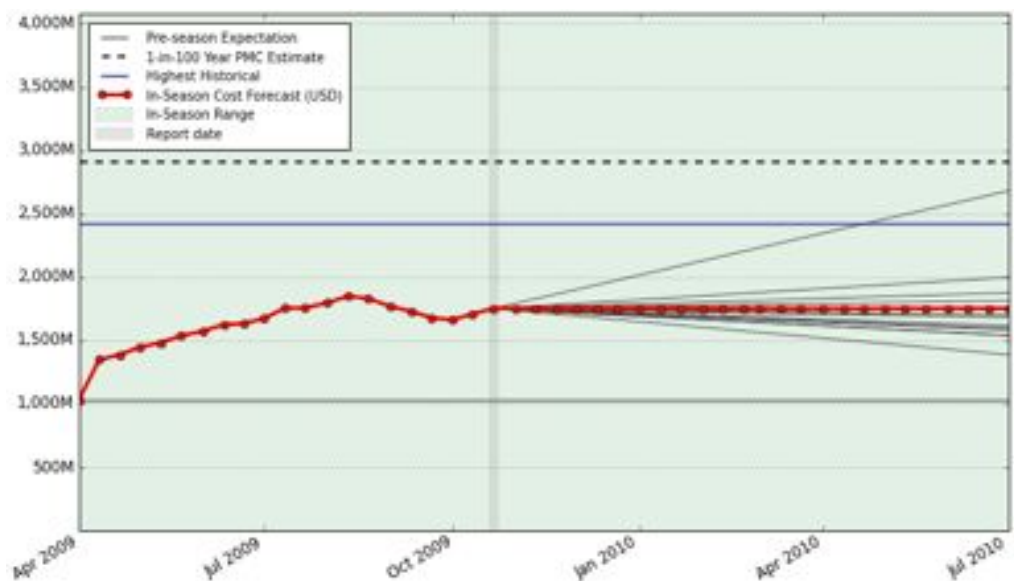
⁷ Floods and cyclone driven losses as well as further climate change analysis follow in 2010.

⁸ For Africa these data are updated every ten days and fed into the software for each of the 261 135 satellite pixels (or squares of about 10 km² near the equator) covering the continent, and can be converted into meaningful indicators for agricultural production and for the vulnerable populations who depend on rainfall for crops and rangeland or are at risk to rainfall or flooding events.

As a fund management tool the software aggregates the costs related to these needs over all African countries where emergency assistance may be needed to project expected costs for an agricultural season and how risks evolve over the year, giving decision-makers the information necessary to manage the risk portfolio financially.

Figure 2: Screenshot of Africa RiskView's in-season cost monitoring functionality updated every 10 days as rainfall estimate data is reported for an all-sub Saharan Africa drought risk portfolio. The example, for an end of October 2009 analysis (denoted as D30 in the figure), shows the estimated portfolio cost for the season-to-date with a future "come of uncertainty", based on historical rainfall seasons, of where costs could go by the end of the portfolio "year" taken as April 2009 to July 2010. PMC denotes "Probable Maximum Cost". As Africa RiskView is still in development, placeholder numbers have been used to illustrate this function. Work is ongoing to incorporate seasonal forecast into the software so that estimates for the remainder of the year can be adjusted by the available forecast information.

Figure 2:
2009/2010 In-Season Cost
Forecast (As-of-D30)
All Seasons/All Countries/
All Areas



Managing a portfolio of risk

States can assess their own
disaster vulnerability...

Governments could use the information generated by ASR and Africa RiskView to assess their own national weather-risk profiles and their capacity to cover costs related to natural disasters. By quantifying the risks in advance, developing countries, together with their neighbours and international partners, including WFP, could develop comprehensive national risk management strategies for all weather-risk scenarios in the most efficient way.

...and potentially create a multi national risk pools...

While each national government could use information from RiskView to build a national risk profile and contingency financing strategy, there is a clear financial incentive to pool different types of weather risk across countries and regions. The African continent can be divided into regions based on their distinct rainfall seasons. Heralded by the annual progression of the Inter-tropical Convergence Zone, which crosses the equator twice a year, these seasons bring with it erratic rainfall, drought and flood risk for vulnerable populations. Within the atmospheric-ocean system, it is unlikely that extreme weather events will happen simultaneously or in the same year in every country and in all regions on both sides of the equator. This diversification means risks do not accrue additionally, to lower the cumulative probable maximum costs of an annual portfolio of countries to a more manageable sum than the probable maximum cost of each country added together.

...to gain climate diversification benefits.

Preliminary results indicate that by pooling their risk across the continent, African nations could halve their weather-related risk management costs. Early estimates show the sum of the worst case 1 in 100 year event exposure of each sub-Saharan African country to drought risk reaches nearly USD 6 billion a year, at an average total cost of assistance of USD 100 per person in case of severe drought. Climatic diversity across Africa creates a powerful portfolio effect that reduces the contingency funding requirement for drought in by half: if African countries pooled their natural disaster risk, the size of this risk pool would be half the size of the sum of contingency funds required if each country prepares autonomously, ie approximately USD 3 billion.

The role of an international organization

International bodies have a key role in coordinating disaster mitigation strategies...

To date, the private sector has not provided services required as a prerequisite to risk management, such as risk identification and analysis, for developing countries, particularly in Africa. International organizations that have strong relationships with key members of governments across the globe, an understanding of the underlying risk in question and resources can provide these services more effectively. An international body must play a co-ordinated role of risk aggregator and “provider of last resort” until a well-regulated market succeeds at pooling risk across regions.

...one of which may be the WFP.

WFP has a long history of working well with governments – even in states with low institutional capacity. The organization has a strong reputation in disaster management and a strong presence on the ground with operational staff in 77 countries around the world that can convert ready monies into effective assistance for the most needy. Starting the initiative within the humanitarian community creates a unique opportunity to take advantage of the best aspects of the current disaster responses system – flexibility, more accurate needs assessments – with those of a contingency financing system more closely aligned with the stricter practices of the international risk markets – timeliness, reliability, objectivity – while minimizing the limitations of both.

Risk modelling has limitations that must be covered by government assumptions...

While the process described above to quantify potential costs with the best methodology and data possible, there are technical and operational limitations to ex-ante risk assessments that could lead to imperfect portfolio cost estimates. First, the technical limitations revolve around not being able to observe weather phenomena accurately over all parts of Africa due to insufficient data. Second, there are uncertainties in the process of converting this data into meaningful drought or flood indicators and then into food security needs estimates.

In reality, needs can occur from a complex interaction of factors beyond those that can be captured by high-level weather-based indicators and additional data is needed to interpret results. In some cases, data is not available to support this process, thus decision-makers may be forced to make assumptions. While the assumptions will be made explicit, they could also be incorrect. These issues of “basis risk” with index-based risk management approaches are well documented in the literature on parametric risk management.⁹ Improvements in remote sensing technologies, climate modelling techniques and additional data monitoring systems to complement weather information, together with progress in understanding how these factors impact the food security of vulnerable populations, will help to reduce these technical limitations over time.

...highlighting the role of flexibility and judgement in reaching assessments.

Given the complexity of humanitarian situations, the prevalence of risks beyond weather, flexibility is critical. Parametric approaches can be powerful strategies to quantify risk ex ante at a high level, open channels of financing at the moment they are needed thereby ensuring immediate liquidity for a full response on the ground once the total impact of weather-related food security risk is quantified. The model might guide assessments. However such approaches should not be used as a sole determinant for response costs. Decision-makers should use the multiple tools at their disposal to design an optimal financing strategy – including traditional approaches.

Looking to the future

Coordinating risk modelling will strengthen the core competencies of the WFP...

While the ultimate and most ambitious goal of the Climate and Disaster Risk Solutions project is to catalyse a needed change in the financing of the international disaster response system by the demonstrating the process of identifying, quantifying and monitoring risk in order to deliver timely, equitable and appropriate responses to extreme weather events, at a minimum the initiative will strengthen WFP as an organization. The internal collaboration necessary to quantify and monitor risk, from data gathering and refining core metrics to development of methodologies that allow the translation of weather data to operational cost, forces feedback loops and communication channels between units within the organization to be even more focused. Ground-truthing estimates on weather-related needs when possible on a regular basis and running checks against historical data will help WFP in its response, fundraising efforts and dialogue with partners. Identifying and quantifying risk should also be a basic pre-requisite for all actors within the humanitarian and development arena.

...as well as highlighting the effects of climate change on vulnerable areas...

Understanding the expected and variable costs of weather-related events that can occur in the coming season not only allows for better preparation in the short-term, but understanding today's risk also opens up powerful opportunities for the future. Climate change will significantly increase the risks faced by vulnerable populations. Changes in weather patterns could significantly impact food-insecure populations and in turn force up humanitarian operational costs. Once the current weather risk is quantified it can be augmented with hypothetical weather scenarios in order to understand the potential humanitarian and financial impact of climate change on food insecure populations.

⁹ For a discussion see: Skees, J. R., P. B. R. Hazell and M. Miranda, “*New Approaches to Public/Private Crop Yield Insurance in Developing Countries.*” Environment and Production Technology Division Discussion Paper 55, International Food Policy Research Institute, Washington, DC, November, 1999. World Bank, “*Managing Agricultural Production Risk: Innovations in Developing Countries.*” Agriculture and Rural Development Department Report 32727-GLB, The World Bank, June 2005.

Such information, based on operational considerations, will help in guiding investment and policy decisions for countries and the international community. In its first climate change stress test, Climate and Disaster Risk solutions will feed through RiskView rainfall and potential evapotranspiration data from RegCM3, a widely tested regional climate model run by the International Center for Theoretical Physics in Trieste, Italy that has been used to downscale to a 50 km resolution data from the General Circulation Model (GCM) ECHAM5 forced with the A1B IPCC emission scenario for the period 1980–2050. This information can be used in the RiskView software to observe – all other factors being held constant – the impact of changing weather on vulnerable populations and the magnitude of the international community’s required assistance. At present, this RegCM3 data, produced under the auspices of the EU project ENSEMBLES, represents the only regional climate model downscaling exercise that has systematically targeted the entire Africa domain. For such stress test results to be used for planning however datasets from many other model and emission scenario combinations should be run through the software so that the uncertainty surrounding future climate projections and therefore costs under a full range of emission and modelling settings can be observed. Under the World Meteorological Organization’s Coordinated Regional Downscaling Experiment (CORDEX), more downscaled GCMs will become available by late 2010 and in 2011. In the meantime, the project will use non-downscaled GCM data and emission scenarios.

...data which can be shared
with a scientific audience.

To ensure that this work will become part of a global public good, Climate and Disaster Risk Solutions methodology will be shared as a platform for development of the Climate Services Application Program and Climate Service Information System – both of which are components of the Global Framework proposed at the World Climate Conference (WCC-3) in Geneva in September 2009. The aim is to accelerate the process of risk identification and analysis for the disaster assistance community. Ultimately the approach can also provide a standard by which the (re)insurance industry can measure, assess and structure risk in developing countries to generate meaningful pricing and business decisions across different firms for assuming such risk¹⁰ and to attract greater private sector involvement in managing natural disaster risk in developing countries.

Climate and Disaster Risk Solutions
will be extensively be tested with
African data...

In the near term, the next steps are to complete the risk modelling and quantification exercise Climate and Disaster Risk Solutions that has started for Africa. Once confident in the product, Climate and Disaster Risk Solutions will begin a virtual contingency financing scheme within WFP for the African continent, with a view to grounding the effort in key developing countries as well as in the donor community. This outreach, sensitisation and proof of concept process will be the first step towards the longer-term goal of securing real contingency financing against the risks countries face. In the long-term, Climate and Disaster Risk Solutions presents a crucial operational product not only for WFP’s decision-makers but for the greater disaster assistance community, governments across Africa and their partners in the private sector. As mentioned above early results from Africa RiskView, focusing on drought, correlate with planned needs estimates from historical WFP responses to drought in Africa to nearly 90% for the past decade for which reliable needs information exists within the organization’s historical records.

¹⁰ An analogy can be found by studying the Global Earthquake Model (GEM) a partnership of the private sector and the Organisation for Economic Co-operation and Development (OECD). It is an independent standard to calculate and communicate earthquake risk, raise awareness, promote mitigation and insurance use and stimulate risk transfer. We hope that in the future Climate and Disaster Risk Solutions and *Africa RiskView* will provide similar services for drought, flood and cyclone risk in Africa, and developing countries around the world.

The establishment of an Africa-wide Risk Facility based on the Africa RiskView drought and floods portfolio may be on the horizon. Given the required size of such a facility, where participating countries as shareholders could pool and manage their risks together, it would need donor and multilateral support, in addition to in some cases, if requested by a country, WFP's operational expertise to assist in converting cash into a timely response in crisis situations.

...and can create the ground-work
for risk management solutions.

To be feasible and sustainable an ideal facility would have hybrid features, selecting the best elements of parametric contingency financing schemes and with the best elements the current traditional emergency appeals system. Parametric contingency financing approaches – such as the Caribbean Catastrophe Risk Insurance Facility (CCRIF) – would enable access to non-traditional sources of financing for the facility such as the financial markets, timely access to funds in the wake of a disaster without the need for lengthy needs assessments and would ensure the facility's overall financial management remained firmly anchored in a quantitative, objective base. However, to be operationally feasible in a crisis context would also require access to complementary mechanisms that would still give participating countries the critical flexibility in determining an appropriate disaster response in circumstances that may not fully be reflected by a model or articulated in their national disaster preparedness and planning process.

Defining this balance will be the challenge ahead, but doing so will make risk pooling through an Africa-wide Risk Facility, and the advantages it promises, possible. In turn such a shift in financing natural disaster responses would give the international community more freedom and flexibility to deal with the demands from other risks – risks such as conflict, pandemics, the global financial crisis – that are not as well-understood or predictable as the weather, but just as important for the world's most vulnerable.

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Addressing the challenges of climate change

Thomas Stocker discusses with David Bresch how the scientific community is contributing to the current debate on climate change. Climate change is an irreversible reality that is already upon us. Those countries, businesses and individuals that embrace the scientific evidence will be in a better position both to mitigate their climate impact and to adapt to their changing circumstances.

Climate change has been a major subject of public debate for some years now. Could you frame the scale of the problem from a scientific perspective?

The scientific understanding of climate and the effect of human activity on it was actually postulated in the late nineteenth century. The greater availability of data, both of weather and rising atmospheric carbon dioxide (CO₂) concentrations, has made the theory increasingly robust since the 1960s. Subsequently, climate change has become an undeniable phenomenon, not only within the scientific community, but within mainstream public opinion. The global atmospheric concentration of carbon dioxide has increased from a pre-industrial value of about 280 parts per million (ppm) to over 386 ppm in 2009. The atmospheric concentration of carbon dioxide in 2009 exceeds by more than 29% the natural range over the last 800,000 years as determined from ice cores from Antarctica. This concentration is causing average global temperatures to increase, snow cover to retreat and sea levels to rise. All these data are extremely well documented and corroborated through many studies.¹

Do you worry that such figures can seem a little abstract for many people?

That might currently be the case – but it has changed as climate change now becomes visible on regional scales. Many are already affected by climate change, such as those living in areas of declining permafrost, or on the low lying lands of Bangladesh. Climate change will become increasingly tangible for all of us in coming years. Let us take, for example, the key element of water management. That not only applies to areas traditionally vulnerable to drought; it will be a key factor in, for example, the Spanish agricultural sector, or here in Switzerland in some of the mountain valleys as the glaciers retreat. Other areas will become wetter. Many major cities – such as London, Shanghai, the Eastern US seaboard – are vulnerable to rises in sea levels. And many of us will likely be exposed to more extreme weather events.

How successful do you think the Intergovernmental Panel on Climate Change (IPCC) has been in highlighting the issue of climate change?

Within our mandate I think we have made great progress. Our mandate is to provide information on the status of knowledge on climate change in a comprehensive way based on peer-reviewed literature to governments. The IPCC does this in regular assessments which have been published every 5–6 years since 1990. We are not a campaigning group. We aim to be neutral, thorough and transparent, and based on scientific objectivity. Success, on our terms, is to be credible in the eyes of policy makers. It has been a long and occasionally tough process, but this we have largely achieved. We have had four assessment cycles in which reports have been produced by the scientific community. These reports have been subject to a three-stage review, one stage of which is undertaken by governments.

¹ For further information on the effects of climate change, see: Fourth Assessment Report, Working Group 1, Intergovernmental Panel on Climate Change (www.ipcc.unibe.ch/publications/wg1-ar4/wg1-ar4.html)

Has the IPCC been a learning curve for the scientific community?

It certainly has. We have to boil down the expertise of hundreds of scientists currently active in this field to understandable and yet precise language. Climate projections are based on a handful of policy options and expected consequences are estimated based on model simulations. This is new territory for many scientists and certainly not an area in which they are always comfortable. However, policymakers themselves rarely have a scientific background. Even if they have, they have numerous other policy considerations landing on their desk day after day. We are in competition for their attention with many other groups.

Is there a danger that messages for politicians are over-simplified? Or that the message of the IPCC is diluted through numerous review cycles?

Often individual scientists would prefer to use stronger language in these reports and summaries. However, we provide an assessment in which we present robust findings based on multiple lines of evidence rather than a risk-based approach which would be supported only by little evidence or uncertain extrapolation. Therefore, these assessments may rather be too conservative, although some media have claimed the contrary. We present a number of scenarios and use scientific methodology to attribute probabilities to certain climate outcomes. Moreover, we also present research results that are more uncertain and less robust. That includes research that suggests climate change is more prevalent than previously thought.

With how much certainty can the IPCC look to the future?

No one can say anything with absolute certainty about the future. There are two independent sources of uncertainty. One concerns natural science. More research will hopefully reduce this type of uncertainty. However, such a reduction of uncertainty may be temporarily reversed as new processes may be discovered to be relevant for climate change. The factor that actually weighs more heavily concerns the choice of emission scenario. There are no scientific laws governing what decisions humans might take. Our own species is the largest variable in our future looking models.

Have you encountered resistance by governments or other groups to the scientific findings of the IPCC?

At the end of the Third Assessment we had intensive discussions at a high level with a number of oil-exporting countries which had expressed their reservations to our report. With the publication of the Fourth Assessment Report most of these parties had come on board to endorse the IPCC and its findings which are based on multiple lines of scientific evidence. Our largest problem currently is lobby groups of special interests which actively oppose the potential policy reactions to the findings of the IPCC. They have changed their tactics. The sceptics used to deny climate change head-on. However, they can no longer credibly do that. What they do instead is question particular aspects of climate change literature with an aim to cast doubt over the whole body of research. Incidentally, a very similar tactic was used in the smoking debate 20–30 years ago.

How can these sort of tactics be countered by the IPCC?

Not easily. We have had four exhausting assessment rounds to inform, to the best of our abilities, the world's governments. I still do not have the feeling that climate change is enough of an issue in domestic politics. Perhaps this is also connected with a growing illiteracy of scientific and technical knowledge in the wider public. The teaching of natural science needs to be enhanced in school. This will improve scientific and environmental understanding. Too much science has fallen by the wayside in recent years, to be replaced by business and economics. To reach a wider public, we need to be clear in our communications and be ready to use the most accessible channels. Here the scientific community has made progress; but there is more that we can do.

Is the global concern of climate change causing a new multidisciplinary science to emerge?

It is certainly bringing together scientific topics as never before. We see this here at the University of Bern with the National Centre of Competence in Research on Climate Change.² Twenty years ago oceanographers would not have mixed a great deal with climate change modellers or those studying the carbon cycle. Now they do. We are collaborating, to the extent that every individual maintains their own specialism, and we are engaged in an exchange of expertise. Climate change embraces so many different fields of research, we are creating a truly multidisciplinary approach to the biggest challenge facing this and coming generations.

Do you think the Stern Report³ helped those concerned with climate change, attaching as it did monetary values to potential climate change scenarios?

This has been extensively debated by my colleagues in Working Group 2 and 3 of the IPCC. Anticipating the cost of a rise in global temperatures involves a huge array of actors and, as New Orleans showed, there are always unexpected factors in natural disasters. Deriving financial indicators from climate change data should really be understood approximate with a large margin of uncertainty, in both directions. Placing a monetary value on climate change and its consequences helps further focus attention. It also builds bridges between science and economics, which I believe will be increasingly important in the future.

Do you believe that business is sufficiently aware of the risks posed by climate change?

The problem in the relationship between business and science, certainly the science of climate change, is that we have different time horizons. We are looking into the upcoming century; businesses, with some exceptions, rarely focus beyond 5–10 years. Our societies are organised into economies that are too focused on short term reporting, quarterly reports and the like. I would like companies to say “what will our business look like in 30 years?” This is a key question for the really successful entrepreneurs, the Bill Gates and the Warren Buffets of the world.

² www.nccr-climate.unibe.ch/summary/index_en.html

³ www.hm-treasury.gov.uk/stern_review_report.htm

How would you advise businesses to position themselves vis-à-vis climate change?

Climate change poses many risks for businesses, not least in a field such as insurance. If there is an increase in frequency and severity of extreme weather events, if there is major coastal flooding or failed harvests, then insurers will have to cover the insured losses. Just as the science of climate change has become multidisciplinary, so business needs to embrace a holistic approach to their risk management. From mitigating the effects of extreme weather to changing regulation from energy use, to securing supply chains, climate change will affect many areas of business. These must be integrated into a single guiding risk management strategy.

How much of a role should governments have in adapting to the risks of climate change?

Climate change is upon us, like it or not. If we shut down all our CO₂ emissions tomorrow, the volume of CO₂ currently in the atmosphere will still have significant effects on our environment for centuries. If the global community recognizes Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC), climate change must be limited. Therefore, the first step is to define a binding climate change target, for example limit the global-mean warming to 2°C. Second, this target directly translates into a schedule for global emissions reductions, with a clear lead by the industrialised countries, which are responsible for the current climate change. Very soon, however, all countries will need to reduce CO₂ emissions. Those who move sooner rather than later will be those most capable of mitigating and successfully adapting to climate change. Countries that provide the right mix of incentives to encourage greater energy efficiency will have a societal and technological edge over others. Also here, first movers take a decisive advantage. This is a principle preached by many, but when it comes to climate change mitigation, magically forgotten. The same is true of business. Climate change is not only a multifaceted risk for businesses, climate change mitigation and adaptation can be an opportunity.

Do you think governments are prepared for such a challenge?

In the recent economic crisis, billions of dollars were mobilised to support the banks. It was a coordinated approach by countries across the world in recognition of the financial gravity of the situation. In some ways, it makes me optimistic and angry at the same time. The potential for global action is there if attention is suitably focused. However, the release of such unimaginable amounts of public money should have been tied to conditions. For example, why help an ailing car industry when all they manage to do after their resurrection is to produce the same old technology? Why bail out banks if they continue to act as they did before? I only hope we do not wait for similar scale environmental disasters before we acknowledge the increasing urgency of action on climate change and certain climate targets have become unachievable. The IPCC will continue to provide the scientific information to the policymakers and the public. We will offer, according to the best research, model-based scenarios of future climate outcomes from the global to the regional and local scale. At that point the job of the scientists is done. It is up to policymakers and the public to act.

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